EVALUATION OF STRENGTH CHARACTERISTICS
OF WINGER PIT AND CRAWFORD PIT GRAVELS
AND THE INFLUENCE OF ADDITIVES UPON THE
PLASTICITY CHARACTERISTICS OF CRAWFORD
GRAVEL FINES

K.A. MILLIONS

APRIL 1959

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PLASTICITY CHARACTERISTICS OF CRAWFORD

GRAVEL FINES

#### A DISSERTATION

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR

THE DEGREE OF MASTER OF SCIENCE

FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
BY

KENNETH ARTHUR MILLIONS, B.Sc.

Edmonton, Alberta April, 1959.

# THE UNIVERSITY OF ALBERTA FACULTY OF GRADUATE STUDIES

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled

EVALUATION OF STRENGTH CHARACTERISTICS

OF WINGER PIT AND CRAWFORD PIT GRAVELS

AND THE INFLUENCE OF ADDITIVES UPON THE

PLASTICITY CHARACTERISTICS OF CRAWFORD

GRAVEL FINES

submitted by Kenneth Arthur Millions, B.Sc., in partial fulfilment of the requirements for the degree of Master of Science.

Professor

Professor

Professor



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### ABSTRACT

The strength characteristics of Winger Pit and Crawford Pit gravels were investigated in a vacuum triaxial testing programme, using specimens 12 inches in diameter by 24 inches high and gravel sizes up to 3 inches. The effects upon the strength of Winger Pit gravel produced by variations in moisture content and by crushing and washing were evaluated. In addition, an evaluation was made of the effects upon the strength of Crawford Pit gravel brought about by the addition of a small quantity of portland cement.

An investigation was also made into the effect with time upon the plasticity characteristics of the fines of Crawford Pit gravel produced by the addition of cement and of lime and fly-ash.

It was found that:

- a) The loss of strength of a gravel, containing an excess of plastic fines, due to an increase in moisture content, results from the low permeability of the gravel.
- b) The permeability of such gravel may be increased by screening, washing, or by the addition of a trace quantity of portland cement.
- c) Crushing of the gravel produces an increase in stability at failure strain, but does not prevent a reduction in stability due to an increase in moisture content.
- d) Both cement and lime and fly-ash produce an immediate reduction of the plasticity index of the Crawford gravel fines. With both additives the Plasticity Index of the fines remains relatively constant after the initial reduction. As curing takes place, the Liquid and Plastic Limits increase with time. This is more noticeable with the cement additive than with the lime and fly-ash.

## TABLE OF CONTENTS

CHAPTER		PAGE
I	Introduction: Purpose, History and Preview of Investigation	1
	PART A	
	MECHANICAL STABILIZATION OF WINGER PIT GRAVEL, WHICH HAD AN EXCESS OF LOW PLASTIC FINES, FOR USE AS A HIGHWAY BASE COURSE	
II	Classification and Analysis of Materials Investigated	9
III	Apparatus and Procedures for the Triaxial Tests	15
IV	Triaxial Testing Programme Results	27
v	Correlation of Test Results with Various Methods of Base Course Design	41
VI	Discussion and Conclusions	50
	PART B	
	AN INVESTIGATION INTO THE EFFECT OF PORTLAND CEMENT AND LIME FLY-ASH ADMIXTURES UPON THE PLASTICITY CHARACTERISTICS OF FINES FROM CRAWFORD PIT GRAVEL WHICH HAD AN EXCESS OF MEDIUM PLASTIC FINES	
VII	Classification and Analysis of Materials Investigated	57
VIII	Apparatus and Procedures Used	59
IX	Testing Programme Results	63
Х	Discussion and Conclusions	71
XI	Discussion of Test Results	74
XII	Conclusions	79
Bibliography		81



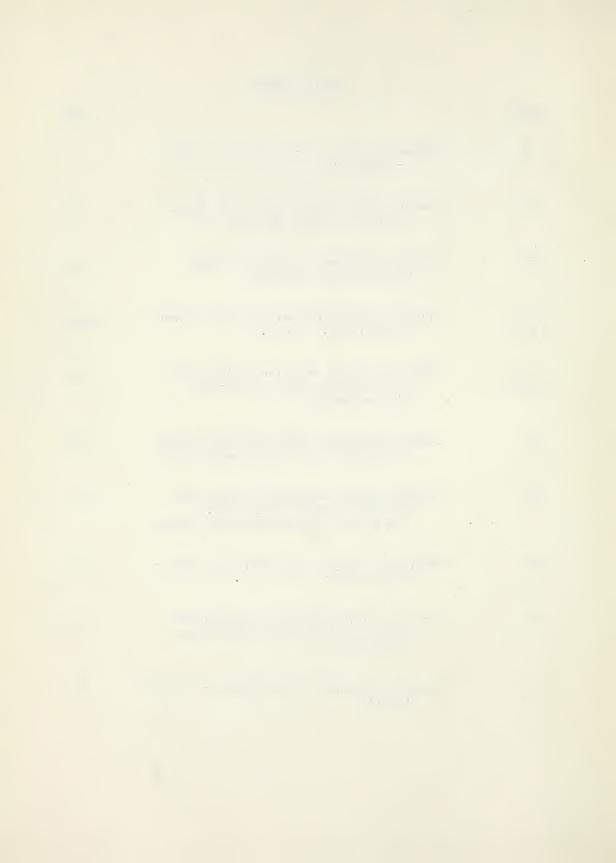
# TABLE OF CONTENTS (Continued)

CHAPTER		PAGE
Appendix A	Sample Computations:  1. Estimating the Optimum Molding Water Contents for Triaxial	
	Specimens 2. Pavement Thickness Requirements	84
	using the Kansas Design Method	84
	<ol> <li>Quantity of Cement required in forming Triaxial Test Specimens</li> </ol>	
	and Compaction Test Specimens	87
Appendix B	Detailed Test Data for Part A	91
Appendix C	Detailed Test Data for Part B	139



# LIST OF TABLES

Table		Page
I	Mechanical Analysis and Plasticity Tests - Winger Pit	9
II	Desired and Actual Gradings of Aggregate used for Triaxial Testing	11
III	Results of Compaction Tests on Winger Minus #4 Sieve Material	12
IV A to F	Results of Triaxial Tests of Winger Gravel Mixtures No. 1 to No. 6	28-33
V A and B	Number of States using the various means of Evaluating Base and Sub-Base Course Quality	42
VI	Asphaltic Pavement Thickness requirements according to the Kansas Design Method	48
VII	Deviator Stress required to produce the Failure Strain of Mixture No. 1 Compacted at Optimum Moisture Content	51
VIII	Mechanical Analysis and Plasticity Tests - Crawford Pit	57
IX	Plasticity Characteristics of Minus #40 Sieve Crawford Gravel with various Admixtures	63
X	Triaxial Compression Test Results - Crawford Gravel	66



## LIST OF FIGURES

FIGURE		PAGE
A	Field Moisture Contents after a Rainstorm, of Winger Gravel Compacted at Optimum Moisture Content	3
1	Details of Triaxial Specimen Forming Mold	- 23
2	Forming Mold Assembled	24
3	Specimen Before Testing	25
4	Specimen after Completion of Loading	26
5A to 5F	Mohr's Stress Circles at Failure and Rupture Lines for Winger Pit Mixtures 1 to 6	34
6 to 11	Stress Strain Curves for Winger Pit Mixtures No. 1 to No. 6	35-40
12	Soil Classifications Texas Method of Base Design	45
13	Plasticity Characteristics versus Time for Crawford Fines and various Percentages of Portland Cement	67
14	Plasticity Characteristics versus Time for Crawford Fines and various Percentages of Lime and Fly-Ash	68
15	Plastic Limit versus Per Cent Cement for Crawford Fines	69
16	Stress Strain Characteristics for Crawford Pit Gravel	70
17	Pavement Thickness Chart - Kansas Design Method	86
18	Surface Area Factors - California Highways Department	90

and the second s

#### CHAPTER I

### PURPOSE, HISTORY AND PREVIEW OF INVESTIGATION

In many parts of Canada, and particularly throughout the Prairie Provinces, known sources of good quality, well graded, clean gravel, for use as highway base course, are rapidly being depleted. This is occurring at a time when, due to increasing thicknesses of base course required to support higher legal truck loads, and to much wider highways being built to accommodate the traffic of today and of the future, vastly higher quantities of gravel are required per mile of highway than was thought necessary as recently as ten years ago. In addition to this, the highway departments are attempting to surface most of their highways with either flexible or rigid pavements; highways which 15 years ago would have remained unpaved. This has meant that it has been necessary to use marginal and sub-marginal gravels for base courses where good quality gravels have not been found within economical hauling distance of a paving project. In some cases, little or no difficulty was experienced in using these poorer gravels, but more often than not, failures in the pavement, ranging from a few localized areas to miles of highway, have occurred and which have been attributed, wholly or in part, to lack of stability within the base course gravel.

One of the two phases of this investigation was to attempt to determine whether or not the stability of Winger Pit gravel\*, which had an excess of low plastic fines, could be improved by crushing to various maximum sizes or by removing a portion of the fines, as would be accomplished in the field by washing. Crawford Pit gravel\*\* was used in the second phase of the investigation. An attempt was made to determine the effect produced

<sup>\*</sup>Winger Pit (SW-14-30-1-W.5) near Carstairs, Alberta \*\*Crawford Pit (SW-33-36-20-W.4) near Stettler, Alberta

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upon the medium plastic fines of this gravel by the addition of small amounts of portland cement, and of lime and fly-ash. Triaxial tests were also run on the second gravel before and after the addition of cement to determine the effect of the cement upon the stability of the gravel.

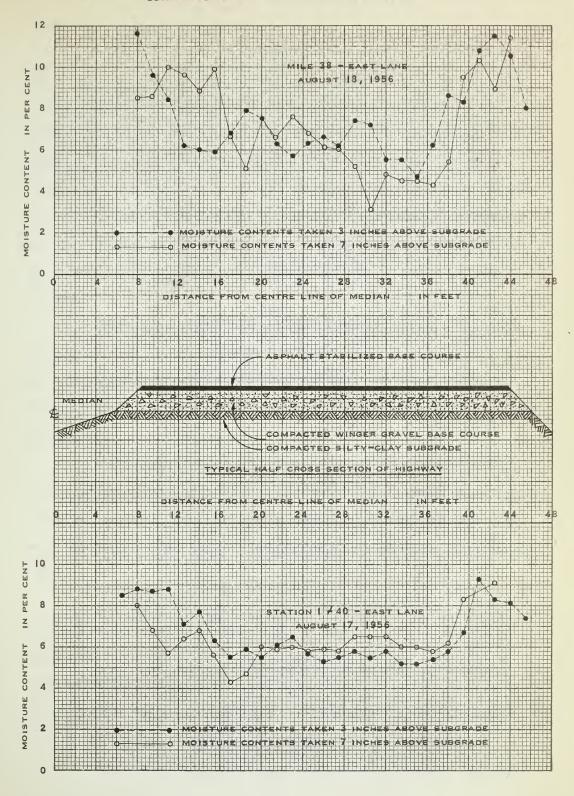
The history of the base course where Winger pit gravel was used is as follows. The 3 inch crushed gravel was used as a base course when constructing Alberta highway number 2 in the summer of 1956, and was employed for base from mile 35 to mile 43 north of Calgary. The gravel was compacted in 6 inch lifts over the compacted subgrade at optimum moisture content until the full height of approximately 12 inches was obtained. It was then covered with two inches of 3/4 inch crushed Winger gravel and two inches of plant mixed 3/4 inch crushed asphalt stabilized base. The cutback asphalt used was an MC4 grade. This usually was carried out within a day or two of the completion of a section of 3 inch base.

The side slopes of the 3 inch base, approximately 3 feet wide, were not protected with the asphalt stabilized base and consequently became saturated during heavy summer rains. The excess moisture in these slopes gradually migrated by capillary action toward the centre of the roadway. This was determined by a definite increasing moisture content gradient in the base course between the centre of the roadway and the sides.\*

The increase in moisture content, with a resulting loss of stability,
was first noticed when the shoulders of the highway commenced to fail under
construction loads. Within a short time failure was general in the shoulder
areas. Little distress in the centre section of the road was noted at this time.

The condition was remedied by ripping the base course, aerating it to dry it to less than optimum moisture content, stabilizing it with an MC2 cutback asphalt and compacting it back into place. The base since then, has been covered with 4 inches of asphaltic concrete pavement, which has been surface treated, and virtually no sign of distress has been noted to







date.

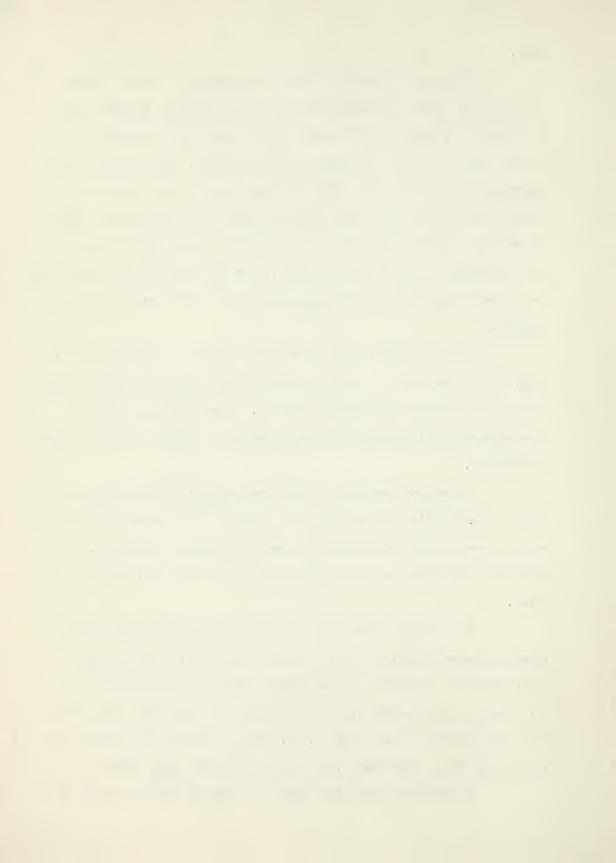
The gravel from the Crawford pit was used as a base course for a section of Alberta highway number 12 near Stettler, Alberta. Due to the medium plasticity of the fines in the gravel, this material was rather difficult to dry to optimum moisture content. This condition was aggravated by the fact that during the construction season frequent showers occurred with the result that the base course was placed, ripped and aerated several times before it was finally covered with 2 inches of 3/4 inch asphalt stabilized base course. The net effect of this re-working was to cause segregation of the aggregate and the final base was not uniform.

Failure in this base course had occurred in several localized areas and in every case it was found that the base below the failed area was both excessively high in fines, and wet. Adjacent areas, where the base material was coarser and at optimum moisture content, showed no signs of distress.

Corrective measures in this case involved excavating the failed areas, replacing the base material with similar gravel compacted at optimum moisture content, and covering the new base with asphaltic material. No major areas have shown signs of failure since the corrective measures were taken.

As aggregate sizes up to 3 inches maximum were to be used in strength determinations, in order that the effect of the whole range of sizes might be considered, it was assumed that the large aggregate in a test specimen would negate the results of any semi-empirical, penetration type, strength tests such as the C.B.R. Other commonly used strength tests, such as the Hveen stabilometer, were rejected for the same reason.

Unconfined compression tests on a granular material cannot be



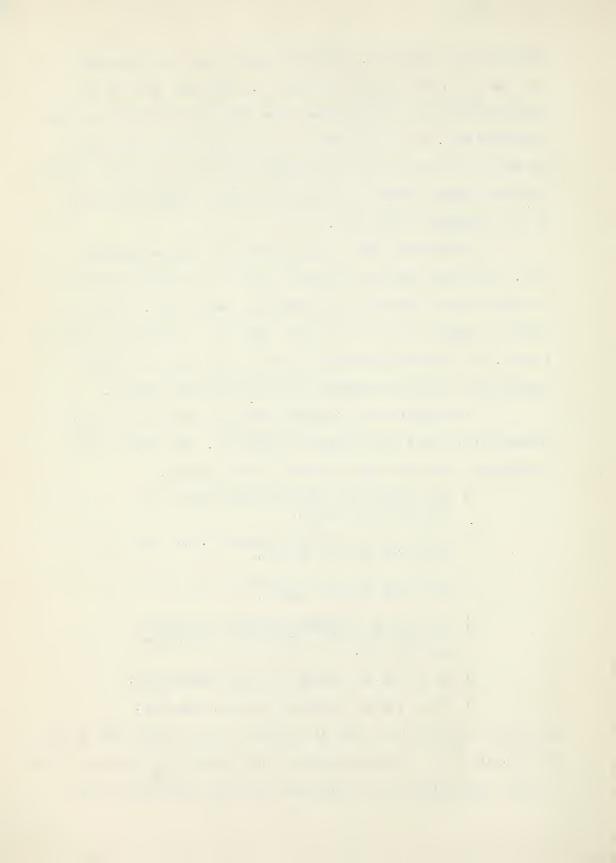
satisfactorily carried out. Thus the triaxial shear test was decided upon for use in the strength investigation. This test, while not as easily carried out as the unconfined, does give more information than the unconfined test. It was decided to use a vacuum triaxial test, that is one where the lateral pressure is achieved by creating a negative pressure within the sample, rather than a positive pressure triaxial test, as it is less cumbersome to carry out.

The specimen size was determined by the maximum aggregate size. It has been found that a minimum ratio of test specimen diameter to maximum particle size of 4 to 1 should be observed (15). A ratio of height to diameter of 2 to 1 is usually employed in cylindrical compression testing. As the maximum particle size was to be 3 inches, a minimum specimen size of 12 inch diameter by 24 inch height was employed.

Classification and compaction tests were carried out on the material to be used in the triaxial investigation. The triaxial tests on the Winger pit gravel were restricted to six mixtures.

- a) The original pit graded aggregate with plus 3 inch material removed.
- b) As for (a) but with approximately 3.5 per cent minus #200 material removed.
- c) As for (a) but with approximately 6 per cent minus #200 material removed.
- d) The original pit graded aggregate, including oversized material, crushed to 2 inch maximum particle size.
- e) As for (d) but crushed to 12 inch maximum size.
- f) As for (d) but crushed to 1 inch maximum size.

As failure occurred in the field at a moisture content greater than optimum, the triaxial tests on the above material were carried out at optimum moisture content, and repeated with the material compacted at a moisture content



somewhat higher than optimum.

This investigation, therefore, attempted to evaluate the relative merits of washing and crushing of the aggregate. An attempt was also made to compare the quality of aggregates by correlating the results obtained with the various methods of base course design in use in Canada and the United States today,

Various authors have reported varying degrees of success in improving characteristics of soils and soil aggregate mixtures using admixtures of portland cement, lime and lime fly-ash. The soils tested have ranged from fine grained medium plastic clay-silt-sand mixtures to relatively clean sands and gravels. The improvements reported were:

- a) A reduction in the plasticity index of the soils
  (3) (17) (18) (19)
- b) A drying effect upon the soils (17)
- c) A greater stability of the soils in unconfined compression, triaxial compression, CBR, and other strength tests (3) (17) (18) (19) (20) (21) (22) (23)
- d) Less susceptibility of the soil to shrinkage and expansion due to changes in moisture content (17) (18) (20)
- e) A smaller loss during wet-dry, and freeze-thaw tests (18) (19) (20) (21) (22)
- f) A much smaller strain at failure under stress (3) (20)
- g) An increase in the optimum moisture content for compaction when lime and fly-ash was used, and a decrease in optimum moisture content when cement was used (21) (22)

Clark (3) noted that the plasticity of the fines of the Crawford gravel was affected not only by the quantity of cement or lime fly-ash employed, but also by the time of curing the mixture. Part B of the Current investigation was to determine the effect of time upon the Liquid and Plastic Limits and Plasticity Index of the fines when treated



with varying amounts of portland cement and of lime fly-ash. A ratio of l part lime to two parts fly-ash was used to conform with Clark's work.

In addition, triaxial shear tests were carried out to determine the effect upon the strength of large (12 inch diameter by 24 inches high) specimens of Crawford gravel, containing all sizes up to a maximum of 3 inches, due to the addition of a small amount of portland cement.



# PART A

MECHANICAL STABILIZATION OF WINGER PIT
GRAVEL, WHICH HAD AN EXCESS OF LOW PLASTIC
FINES, FOR USE AS A HIGHWAY BASE COURSE



### CHAPTER II

## CLASSIFICATION AND ANALYSIS OF MATERIALS

## INVESTIGATED

The source of the gravel used in this part of the investigation was the Winger Pit (SW-14-30-1-W5) near Carstairs, Alberta. A visual examination of the native gravel, as well as grading and Atterberg Limit tests, showed that the material corresponded to the GF soil group of the Casagrande Airfield Classification System (1), and to an A-2-4 soil with a Group Index value of 0 as determined by the AASHO Classification System (2).

Table I shows the average results of the sieve analysis and

Atterberg Limit tests carried out on some twenty samples throughout
the pit by the Testing Laboratory of the Alberta Department of Highways.

TABLE I MECHANICAL ANALYSIS AND PLASTICITY
TESTS - WINGER PIT

2%

04620236 (.2)	5m / O
Sieve	% Passing
3"	100
1½"	75
3/4"	56
#4	36
#10	31.5
#40	26.2
#200	14.4

Oversize (#3")

# Atterberg Limits on - #40 Portion

Liquid Limit 23.7

Plastic Limit 15.5

Plasticity Index 8.2

It may be noted that all Atterberg Limits were carried out after the material had been allowed to soak 24 hours at a moisture content near the plastic limit.

As this investigation intended to determine any variation in strengths of the native gravel due to crushing to various maximum sizes, or to a reduction in the minus #200 portion of the gravel, six different mixtures were employed. The mixtures were obtained by separating the aggregate, by dry sieving, into ten size groups and re-combining to obtain the desired gradation. The mixtures which were to be crushed were first identically combined and then crushed to their respective maximum sizes. The results of the desired gradings and the actual gradings obtained, as determined from sieve analyses at the conclusion of triaxial testing, are shown in Table II.



TABLE II DESIRED AND ACTUAL GRADINGS OF

AGGREGATE USED FOR TRIAXIAL TESTING

Percentage Passing Designated Sieve

Sieve No		x #1	Mix		Mix	MIT THE SHOPE	Mix 7	100110	Mix #	-	Mix #	Divinio .
	D.	Α.	D.	Α.	D.	Α.	D.	Α.	D.	Α.	D.	Α.
Oversize	-	-	-	-	-	-	2	-	2	<del>-</del> .	2	-
3"	100	100	100	100	100	100	98	-	98	-	98	-
2"	-	-	-	-	-	-	-	100	-	100	-	-
12"	75	73	75	76	75	77	73	95	73	99	73	100
1"	-		-	-	-	-	-	84	-	88		99
3/4"	56	56	56	57	56	58	55	69	55	73	55	87
#4	36	36	35	35	34	33	35	42	35	44	35	46
#10	31.5	33	29.5	30	27.5	28	31	38	31	41	31	41
#40	26.2	26	21.5	22	18.5	20	25.6	29	25.6	32	25.6	32
<b>#200</b>	14.4	15.0	10.0	11.4	7.0	9.2	14.1	17.3	14.1	18.5	14.1	19.1

The Atterberg Limits of the minus #40 sieve portion of the original aggregate sample were:

Liquid Limit	21.2
Plastic Limit	12.5
Plasticity Index	8.7

The specific gravities of the coarse and fine fractions of the Winger Gravel used in the triaxial shear experiments were as follows:

Specific Gravity of 7 #4 material = 2.71

Specific Gravity of - #4 material = 2.68

In the combination of 65% coarse, 35% fine, the average specific gravity of the mixture would be 2.70.

The data for the sieve analysis tests, summarized in Table II, and for the Atterberg Limits and Specific Gravity tests are contained in Appendix B.

The results of compaction tests run on the minus #4 sieve portion of mixtures number 1, 2 and 3 are shown in Table III. The results obtained were used in estimating the optimum moisture content to be used for each aggregate mixture. The minus #4 sieve portion for mixtures number 4, 5 and 6 were considered to have the same optimum moisture content as for mixture number 1, insofar as the original fines were concerned, and an optimum moisture content of 5% for the fines resulting from crushing.

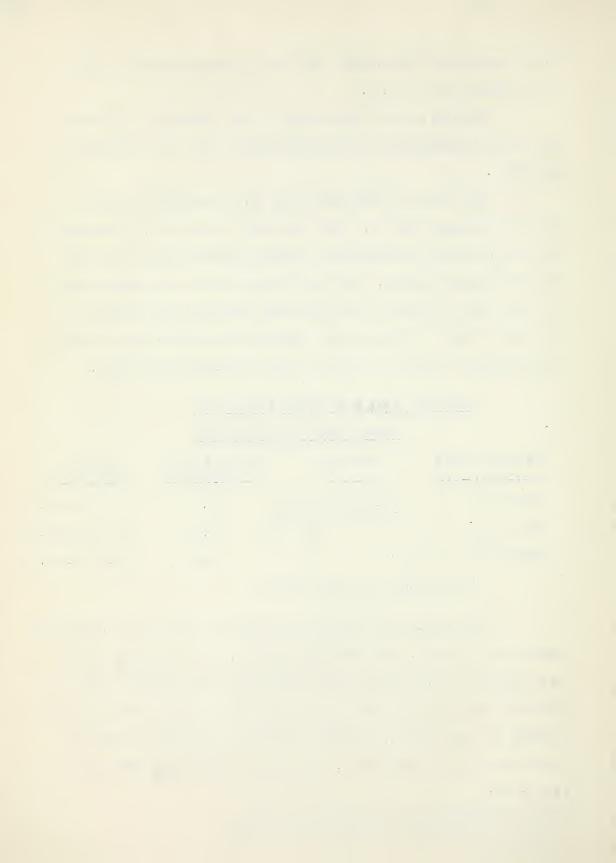
TABLE III RESULTS OF COMPACTION TESTS ON
WINGER MINUS #4 SIEVE MATERIAL

Material Tested	Test Type	Optimum Moisture Content	Maximum Dry Density
Mixture #1	½ Standard Proctor* (3 lifts, 13 blows)	11.5%	121.9 lbs./cu.ft.
Mixture #2	(5 IIILS, 15 DIOWS)	10.7%	124.4 lbs./cu.ft.
Mixture #3	11	10.7%	125.7 1bs./cu.ft.

(See Appendix B for data sheets)

The absorption of the coarse aggregate was found to be 1.8% from the specific gravity tests. Thus from the compaction tests, absorption of the coarse aggregate, and by arbitrarily choosing an optimum moisture content of 5% for the fines produced from crushing, the optimum molding water content was estimated for each mixture. A sample computation of the water content for Mixture #4 is given in Appendix A. The optimum molding water contents were found to be:

<sup>\*</sup>One-half Standard Proctor compaction was used in order to correlate results with those obtained by Clark (3).



Mixture	#1	5.3% water
Mixture	#2	5.1% water
Mixture	#3	5.0% Water
Mixture	#4	5.4% water
Mixture	<i>#</i> 5	5.5% water
Mixture	#6	5.6% water

The above figures are merely estimates, as, though the average compaction energy per unit volume was the same for the compaction tests as was used in forming the triaxial specimens, the following factors differed between the two tests:

- a) the maximum particle size,
- the ratio of maximum particle size to specimen diameter,
- c) the ratio of specimen height to diameter,
- the number and thicknesses of the layers used in forming the specimens,
- e) the compaction hammers used,
- f) the technique of compaction, i.e. With the compaction test, a constant number of blows per layer was employed, whereas in forming the triaxial specimens, the number of blows increased with each layer from 44 to 68 in an effort to effect a uniform final density throughout the sample.

In spite of these differences, it was felt that the values of molding water contents obtained above were reasonable, and in any case, were comparable in evaluating the strengths obtained with the various mixtures.

A second series of triaxial tests were run at a molding water content of approximately 1% above the optimum for each mixture, or at an



approximate average moisture content of 6.3 per cent. At this moisture content it was felt that the degree of saturation was close to the maximum obtainable by compacting the aggregate at a moisture content in excess of optimum, without producing an excessive loss of unit weight.

The computed degree of saturation for specimens compacted near optimum moisture content varied from 38 to 62%. The average degree of saturation was 48%, and 13 out of 18 specimens had a degree of saturation between 43 and 53%.

For specimens compacted over optimum moisture content, the computed degree of saturation varied from 46 to 83%. In this case the average degree of saturation was 70%. Out of 18 such specimens, 13 had a degree of saturation between 60 and 80%.

The computed values for degree of saturation given above are only approximate. Actual values would be somewhat higher than indicated due to the fact that actual volumes of specimens were less than the computed volumes. Specimen volumes were computed using the forming mold diameter which was larger than the actual specimen diameters due to the roughness of surface of the specimens.



#### CHAPTER III

## APPARATUS AND PROCEDURES FOR TRIAXIAL TESTS

## APPARATUS

The detailed plans of the vacuum triaxial forming mold, 12 in. diameter by 24 in. high, used in forming the specimens, are shown by Clark (3). The forming mold is illustrated in Figures 1 and 2 at the close of Chapter III.

A list of equipment used in conjunction with the vacuum triaxial testing programme follows.

- (1) A Tinius Olsen 30,000 Kgm. capacity hydraulic compression testing machine was used for applying the load to all specimens.
- (2) A stable steel compaction table of approximately the same height as the bed of the Tinius Olsen machine was used to support the specimens during compaction. The table was used, rather than compacting the specimens on the concrete floor, to facilitate the moving of the specimens (approximate weight with base plate and head, 325 lbs.) into the Tinius Olsen machine for testing.
- (3) A vacuum source included a single stage vacuum pump, capable of exhausting nearly a full atmosphere, reservoir, a supply of air lines with quick coupling connectors, and a water trap to prevent moisture from entering the vacuum pump and reducing its effectiveness.
- (4) A small heavy metal plaster boat and shovels were used when mixing water with the sample.
- (5) A 1000 lb. capacity platform scale was used for determining the weight of sample used in forming each specimen.
- (6) A 100 lb. capacity scale was used to weigh out the quantity of each size of aggregate to be used.
- (7) A 21 Kgm. capacity solution balance and a large forced draft

• • oven were used to determine moisture contents of the samples.

(8) The triaxial specimen molding and testing equipment included a rubber lined aluminum split forming mold, top plate, base plate, compaction hammer (Marshall hammer\*with 12 ins. added to the fall), strain dial of 3 in. travel in 0.001 in. increments, and a circumference gauge. The circumference gauge consisted of a steel tape, graduated in increments of 1/32 in., mounted at mid-height around the circumference of the specimen on small plastic rollers. The gauge was held taut by an elastic band which allowed the gauge to distend with the bulging of the specimen during testing. Figures 3 and 4 show the circumference gauge in place immediately preceeding and following a test respectively.

## PROCEDURE

The procedure followed in the various triaxial tests was:

- (1) The native gravel was split into ten size ranges by dry sieving after the gravel had been subjected to 50 revolutions in the Los Angeles abrasion machine. No degradation of the gravel was noted, but the abrasion was sufficient to partially clean the sand and gravel particles of their coating of clay and silt and thus a better separation of the gravel into the various sizes was possible.
- (2) Batches of 240 lbs. were made up for each of the aggregate mixtures required, taking into account in each weight of aggregate size used, the residual sizes adhering to the aggregate size, and the hygroscopic moisture content of each size in question. This was accomplished by carrying out a washed sieve analysis and a moisture content determination of air dried material on each of the aggregate sizes prior to combination of the aggregate. The 240 lb. batches were made up as follows in order to approximate the required gradation.

 $<sup>\</sup>tilde{A}$  standard Marshall hammer consists of a 10 lb. sliding weight falling 18 inches onto a 3 7/8 inch diameter face.



## WEIGHT OF SIZES IN POUNDS \*

MIXTURE NUMBER	1	2	3	4, 5 & 6
/3 in.	-		-	4.8
-3 in. / 2 in.	36.0	36.0	36.0	35.3
-2 in. / 1½ in.	24.3	24.1	24.1	23.8
$-1\frac{1}{2}$ in. $\neq 3/4$ in.	45.6	45.5	45.5	44.8
-3/4 in. / 3/8 in.	30.1	31.3	35.2	29.5
-3/8 in. / #4	26.4	28.1	26.4	25.8
-#4 <i>f</i> #10	7.8	10.3	14.3	7.6
-#10 <i>f</i> #40	30.2	34.6	28.7	29.6
-#40 <i>f</i> #200	29.8	31.7	31.0	29.2
-200	11.7	69	**	11.5
	economic confidence		011.0	annuarioumnen
TOTAL	241.9	241.6	241.2	241.9

The batches for mixtures 4, 5 and 6 were then crushed to their respective maximum sizes of 2 inches, 1½ inches and 1 inch.

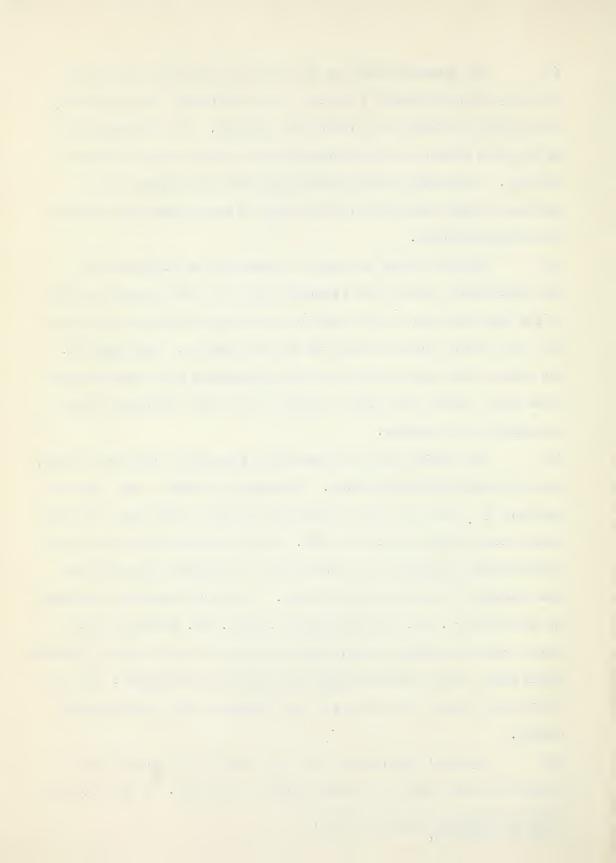
- (3) Samples of 30 lbs. each were then made up of minus #4 material for determining the maximum density and optimum moisture content for each of the mixtures. The batches for the compaction tests were made up in a similar fashion to the procedure used in determining the weight of each size as described in (2) above. Mixtures numbered 4, 5 and 6 were considered to have the same optimum moisture for the per cent passing the #4 sieve as had mixture number 1.
- (4) The optimum moisture content of a specimen was then computed, and, knowing the hygroscopic moisture content of the specimen, the amount of water to be mixed with the aggregate was computed.

<sup>\*</sup>The weights here are batching weights and do not refer to actual grain size distribution. For actual grain size distribution after Triaxial testing see Table II, Chapter II

- (5) The aggregate batch was then placed in the metal plaster boat, mixed dry for approximately 2 minutes, and then the water was added slowly while mixing continued for an additional 5 minutes. All mixing was done by hand with shovels, and was continued until a uniform colour had been achieved. The sample was then covered with two layers of damp jute sacking to retard evaporation and the weight of moist sample plus boat was obtained and recorded.
- (6) Prior to mixing the sample, the membrane was attached to the base plate which rested on the compaction table, the mold carefully placed on the base and bolted, and the membrane was stretched over the top of the mold and a vacuum applied between the mold and membrane. (See Figure 2). The effect of the vacuum between the mold and membrane was to hold the membrane snugly against the interior surface of the rubber lined mold during compaction of the specimen.
- (7) The specimen was then compacted in the mold in seven equal layers, using the modified Marshall hammer. The number of blows on each layer was increased by 4 blows per layer starting with 44 blows on the first layer and ending with 68 blows on the last layer. This was done in order that a more uniform density throughout the specimen would be effected than would have been obtained by using 56 blows per layer. The total compactive energy used was thus 9,800 ft. lbs. or approximately 6,125 ft. lbs. per cubic foot.\*

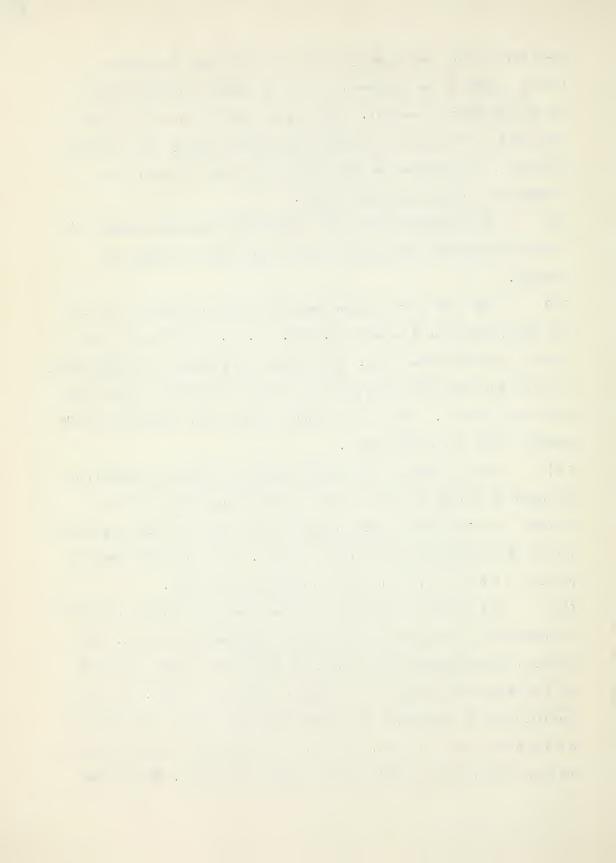
  Special care was used when compacting the top layer to insure that a reasonably smooth plane surface had been formed when compaction was complete. This was difficult to achieve when the samples were compacted over optimum moisture content.
- (8) Any small depressions in the top surface of the specimen were filled with fines, which were tamped carefully into place. A thin layer of

<sup>\*</sup> This was the same compactive effort used by Clark (3).



20-30 Ottawa sand, approximately 1/16 to 1/8 inch thick was spread on the top surface of the specimen to provide as smooth a bearing surface for the top plate as possible. The top plate was then carefully lowered into place on the top of the specimen and rotated slightly under pressure to seat it. The membrane was then drawn up and over this plate and attached to it using long rubber strips.

- (9) The remainder of the sample and the boat were then weighed and recorded to determine the weight of moist sample used in forming the specimen.
- (10) The leads to the vacuum reservoir were then coupled to the top and bottom plates and a vacuum of 0.9 Kgm./ sq. cm. was obtained in the reservoir with the vacuum pump. The specimen was evacuated for approximately 5 minutes and then the forming mold was unbolted and carefully removed from around the specimen. Leaks in the membrane were located and patched with membrane rubber and rubber cement.
- (11) When all leaks in the membrane had been located and patched, as evidenced by no drop in reservoir vacuum with the pump turned off, the specimen was eased from the compaction table onto the bed of the compression testing machine where it was carefully centred. The specimen was moved by pushing on the base plate so as not to disturb the specimen.
- (12) The length of the specimen was measured at four points around the circumference of the specimen and the result averaged and recorded. The hydraulic testing machine was started, the table of the machine "floated" and the machine was zeroed for the range of loading to be used. The self-levelling head of the machine was brought down until contact was made with the top plate of the specimen. The strain dial indicator was then placed in position and an initial reading of the indicator was taken. The specimen

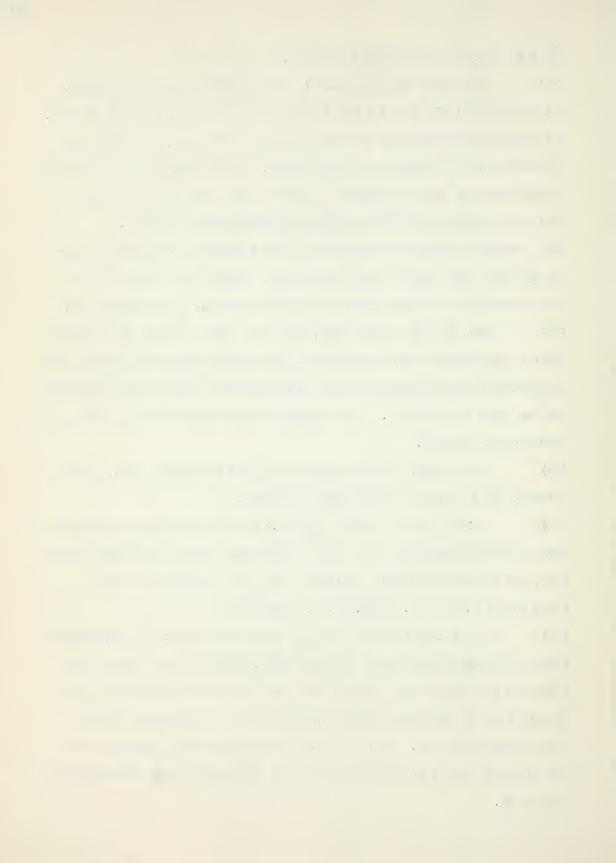


was then ready for testing. (See Figure 3.)

- (13) Loading of the specimens was carried out at a rate of 100 Kgm.

  per minute (3% to 7% of the total load at failure for all specimens tested).

  The testing machine was not designed to be used for constant strain, thus a constant rate of loading was used instead. As all mixtures were subjected to this constant rate of loading, it was felt that the results obtained would be qualitatively, if not absolutely quantitatively, correct.
- (14) Periodic simultaneous readings of load and strain were made throughout the test until failure had been reached. Failure was deemed to have been reached when a large strain occurred at the same, or a reduced load.
- (15) When failure had occurred, the final strain reading was obtained and the load removed from the specimen. The vacuum leads were removed, after the specimen had been moved back onto the compaction table, and the membrane and top plate were removed. In all cases the specimen stood erect after removing the membrane.
- (16) The specimen was then dumped back into the plaster boat, mixed slightly and a moisture content sample obtained.
- (17) A small amount of water (100 cc.) was then mixed into the aggregate to offset evaporation, the lumps of aggregate mixture thoroughly broken down, and the above procedure repeated twice using vacuums within the specimens of 0.60 and 0.30 Kgm./sq.cm. respectively.
- (18) At the completion of the three tests on one mixture of aggregate, the moist aggregate was placed in metal drums, the drums were covered and placed in the moist room overnight to be used the following day when three further tests, at the same lateral pressures but with increased moisture content, were performed. When it was not possible to carry out these tests the following day, a new moisture content of the material was obtained before proceeding.



(19) The following day, after the moisture content samples had been dried, weighed and cooled, the water lost by each sample was replaced, the samples mixed back into the aggregate mixture and additional water added to the mixture to increase the moisture content to the desired higher moisture content.

This procedure, it is realized, was not ideal. A new air dry sample should have been used for all six tests on one mixture. However, this was not possible as sieving, crushing and handling equipment, storage space and time were all limited. As it was, it was necessary to prepare over a ton of Winger aggregate for these tests, and, if a new sample had been used to form each specimen, a minimum of 5 tons of material would have been needed.

- (20) When the mixture had been prepared at the higher moisture content, the above procedure, steps (5) to (17) were then repeated for three tests having lateral pressures of 0.30, 0.60 and 0.90 Kgm./sq.cm. The following exceptions in the case of the specimens with high moisture contents may be noted:
  - a) As difficulty was experienced in obtaining a vacuum throughout the sample, "dressmakers" felt was cemented to the inside surface of the membrane. This felt, approximately 0.04 inches thick, reduced the diameter of the specimen slightly but provided a free draining region between the membrane and the specimen and permitted the setting up of the vacuum throughout the specimen. Again the required vacuum was checked on the gauge, for a minimum 30 minutes before testing commenced, to insure that there was no reduction in vacuum.



b) As failure stress was not obvious with the wet specimens, due to extreme bulging which permitted increasingly higher loads, a circumference gauge was used to determine the area of the specimen at each increment of load. An initial reading of this gauge was obtained before loading commenced and readings were obtained simultaneously with those of load and strain. Loading was continued until the strain had reached the limit of the 3 inch dial indicator, at which time the load and circumference gauge readings were noted. In a majority of the cases, the maximum deviator stress, as computed using the area determined from circumference gauge readings, was obtained at a load somewhat lower than the maximum load on the wet specimen. Figures 3 and 4 show the circumference gauge in place before and after testing such a specimen.



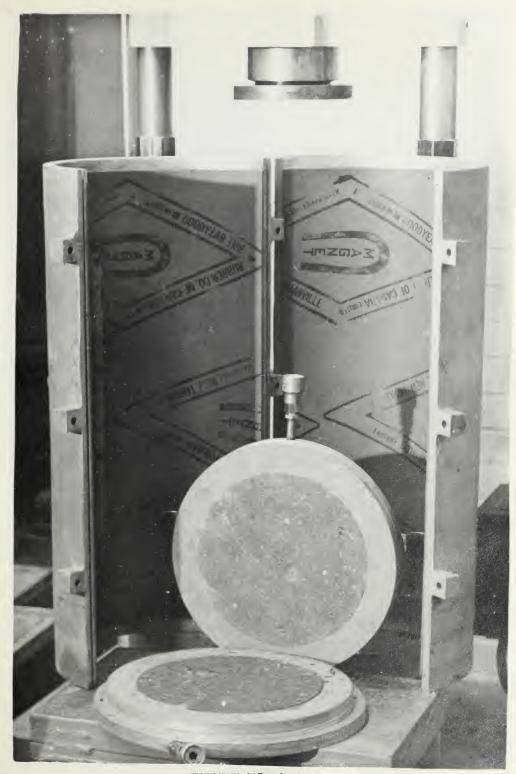
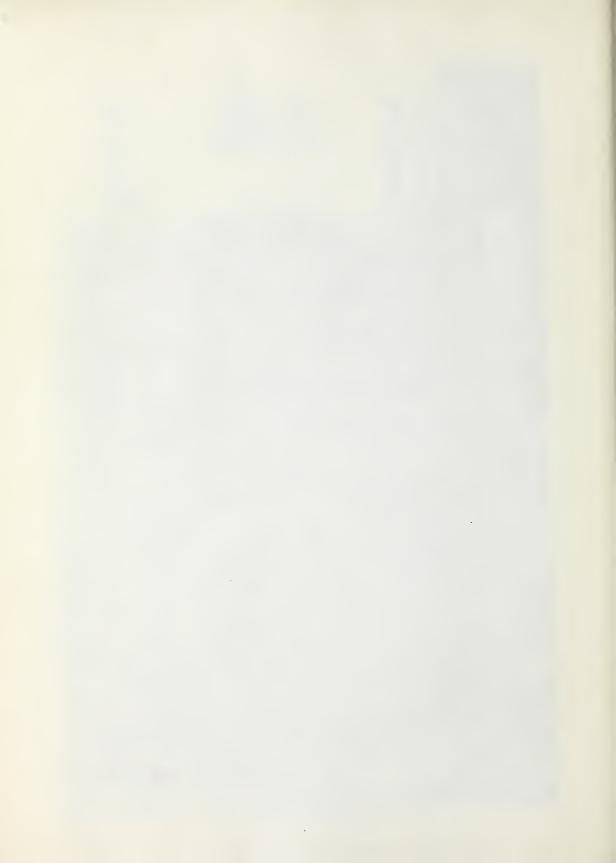


FIGURE NO. I
DETAILS OF TRIAXIAL SPECIMEN FORMING MOLD



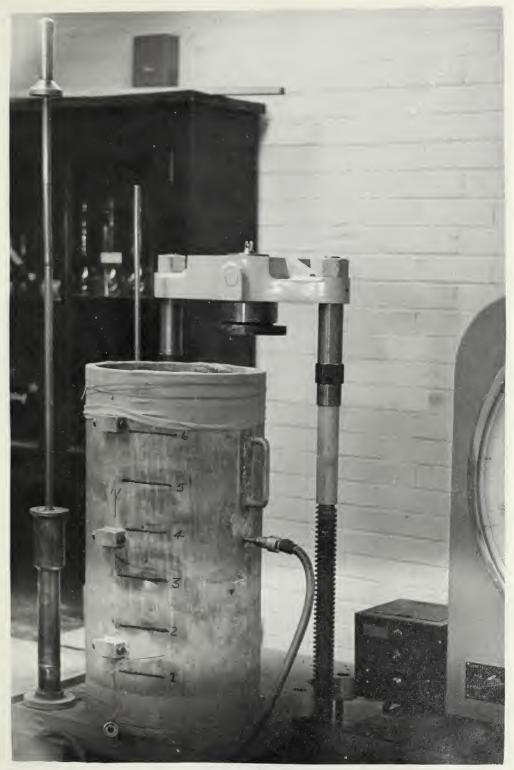


FIGURE NO. 2
FORMING MOLD ASSEMBLED





FIGURE NO. 3
SPECIMEN BEFORE TESTING



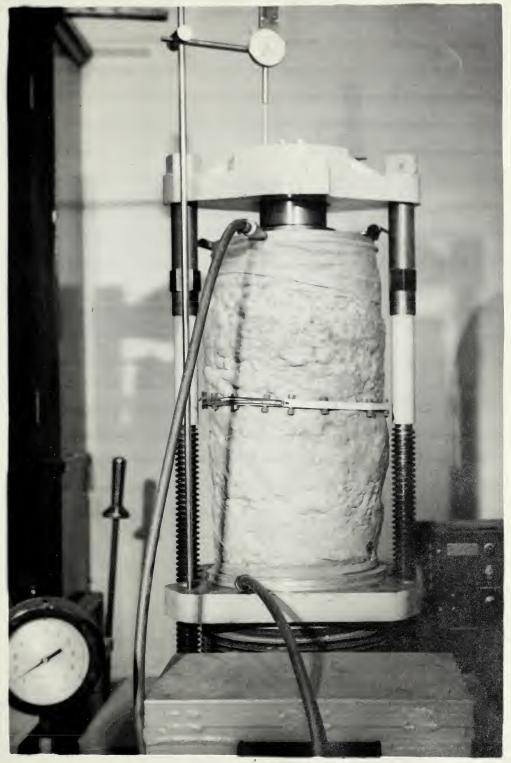


FIGURE NO. 4
SPECIMEN AFTER COMPLETION OF LOADING



#### CHAPTER IV

#### TRIAXIAL TESTING PROGRAMME RESULTS

The results of all vacuum triaxial tests carried out on Winger gravel are shown in tabular form in Table IV A to Table IV F inclusive, depending upon the aggregate mixture used. The data sheets for all triaxial tests on Winger gravel are included in Appendix B.

In addition to the above, the results of the testing programme are shown in other forms. Figures 5A to 5F inclusive show Mohr stress circles at failure and rupture lines for the six mixtures of aggregate both when compacted near optimum moisture and when compacted at approximately 6.3% moisture content. Figures 6 to 11 inclusive show the stress strain characteristics of each mixture when compacted near optimum moisture content and over optimum moisture content.



TABLE IV A

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL - MIXTURE NO. 1

(3" native pit-run gravel)

Angle of Internal Friction	degrees			34			30	
Conesion	Kgm./sq.cm.			4.0			4.0	
Strain at Failure	%	2.14	3.30	3.47	0.9	9.5	9.6	
Deviator Stress at Failure	Kgm./sq.cm.	1.96	2.94	3.73	1.73	2.62	3.00	
Lateral <u>Pressure</u>	Kgm./sq.cm.	0.30	09.0	06.0	0.30	09.0	06.0	
Moisture* Content	<b>%</b>	5.2	5.2	5.2	6.5	6.5	6.5	
Dry Unit Weight	lbs./cu.ft.	132.7	133.4	135.3	133.2	133.3	137.4	
Moist Unit Weight	lbs./cu.ft.	139.6	140.3	142.3	141.9	142.0	146.3	

\* Moisture contents shown are averages of moisture contents of three consecutive test specimens re-using the same sample.

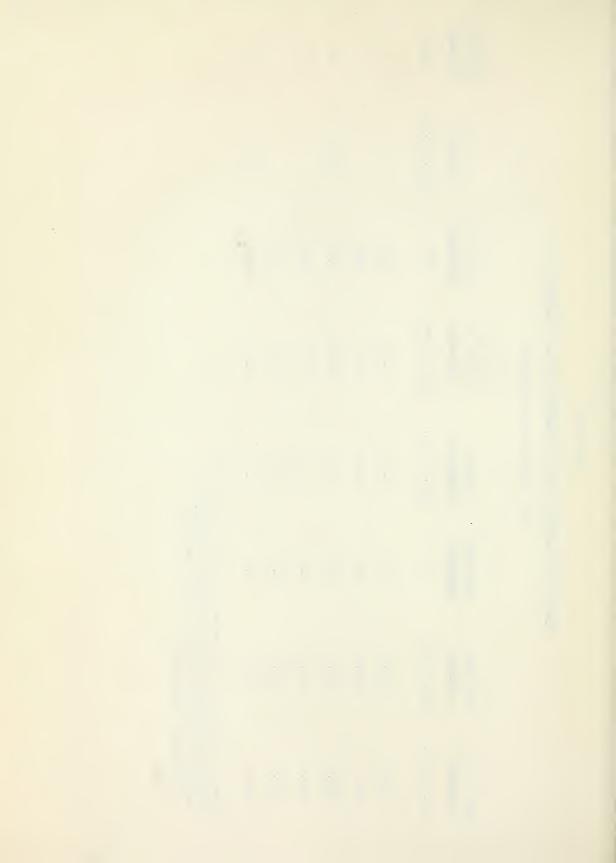


TABLE IV B

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL -- MIXTURE NO. 2

(3" native gravel with 3.6% minus #200 removed)

Angle of Internal Friction	degrees			41.5			35
Cohesion	Kgm./sq.cm.			0.25			0.25
Strain at Failure	%	1.56	1.69	2.50	4.5	4.5	0.9
Deviator Stress at Railure	Kgm./sq.cm.	2.16	3.52	4.54	1.78	2.62	3.25
Lateral Pressure	Kgm./sq.cm.	0.30	09.0	06.0	0.30	09.0	06.0
Moisture	°)	9.4	9.4	9.47	5.9	5.9	5.9
Dry Unit Weight	lbs./cu.ft.	130.5	132.0	132.3	134.1	134.9	137.0
Moist Unit Weight	lbs./cu.ft.	136.5	138.1	138.4	142.0	142.7	145.0

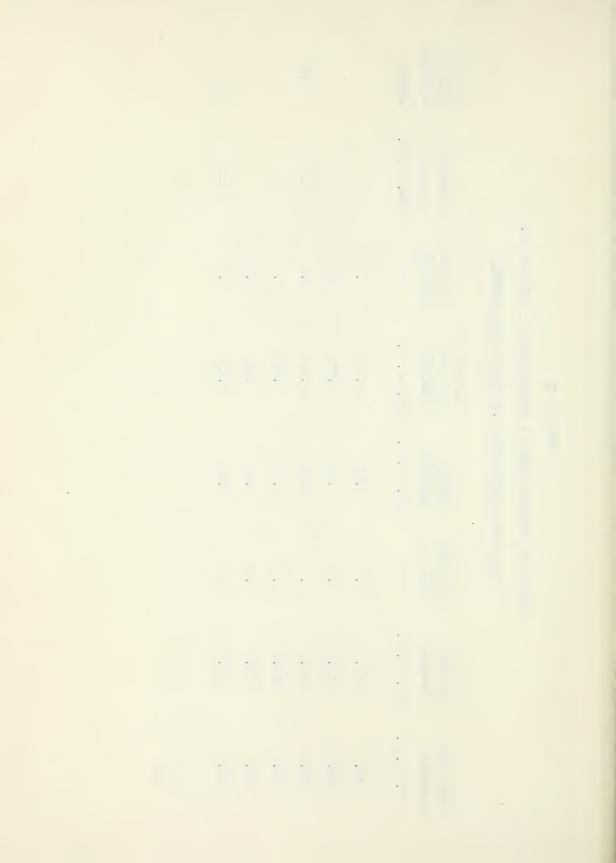


TABLE IV C

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL - MIXTURE NO. 3

(3" native gravel with 5.8% minus #200 removed)

Angle of	Internal	degrees			41.5			37
	Cohesion	Kgm./sq.cm.			0.2			0.2
	Strain at Failure	<b>%</b>	1.64	2.33	2.61	0.9	12	good good
Deviator	Stress at Failure	Kgm./sq.cm.	1.88	3.50	4.28	1.70	2.50	2.80
	Lateral	Kgm./sq.cm.	0.30	0.65	06.0	0.30	0.60	06.0
	Moisture	6/	4.8	4.8	8°7	6.5	6.5	6.5
	Dry Unit Weight	lbs./cu.ft.	135.0	133.5	139.1	136.9	138.0	138,5
	Moist Unit Weight	lbs./cu.ft.	141.2	139.8	145.7	145.7	146.9	147.4

TABLE IV D

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL - MIXTURE NO. 4

(3" native gravel crushed to 2 in. maximum)

Angle of Internal Friction	degrees			39.5			36
Cohesion	Kgm./sq.cm.			0.25			0.25
Strain at Failure	%	2.96		2.94	3.25	5,5	7.0
Deviator Stress at Failure	Kgm./sq.cm.	2.08		4,11	1.74	2.58	3.53
Lateral Pressure	Kgm./sq.cm.	0°30	09.0	06.0	0.30	09.0	06.0
Moisture	6%	5.4	5.4	5.4	6.1	. 9	6.1
Dry Unit Weight	lbs./cu.ft.	128.4	127.0	130.1	123.7	124.6	129.3
Moist Unit Weight	lbs./cu.ft.	135.3	134.0	137.2	131.2	132.2	137.2

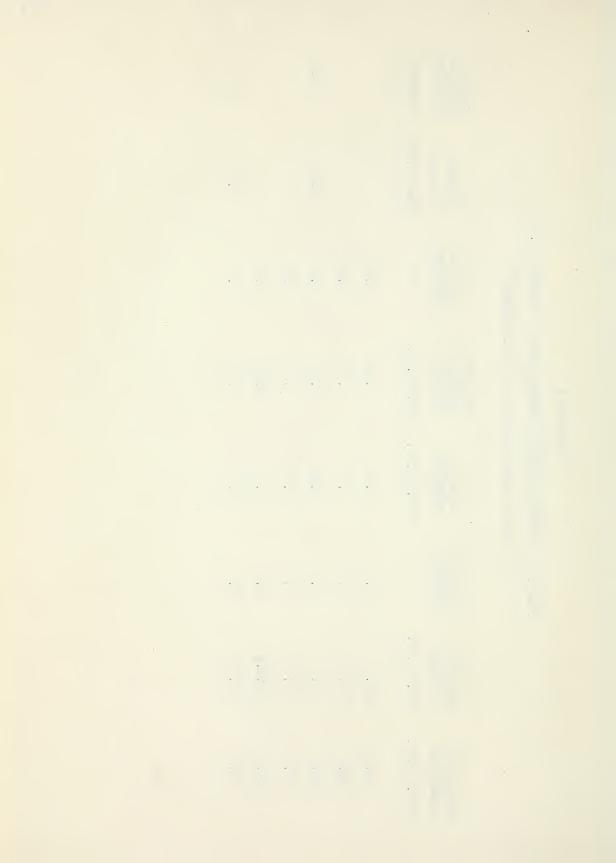


TABLE IV E

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL - MIXTURE NO. 5

(3" native gravel crushed to  $1\frac{1}{2}$ " maximum)

Angle of Internal Friction	degrees			43			38
Cohesion	Kgm./sq.cm.			0.15			0.15
Strain at Failure	%	3.18	5.21	67.4	7.5	8.0	9.5
Deviator Stress at Failure	Kgm./sq.cm.	2.01	3.16	4.57	1.68	2.53	3.54
Lateral <u>Pressure</u>	Kgm./sq.cm.	0.30	09.0	06.0	0.30	09.0	06.0
Moisture	82	5.2	5.2	5.2	7.9	4.9	6.4
Dry Unit Weight	lbs./cu.ft.	130.9	131.6	123.1	135.5	137.2	136.8
Moist Unit Weight	lbs./cu.ft.	137.7	138.5	129.5	144.2	146.0	145.7



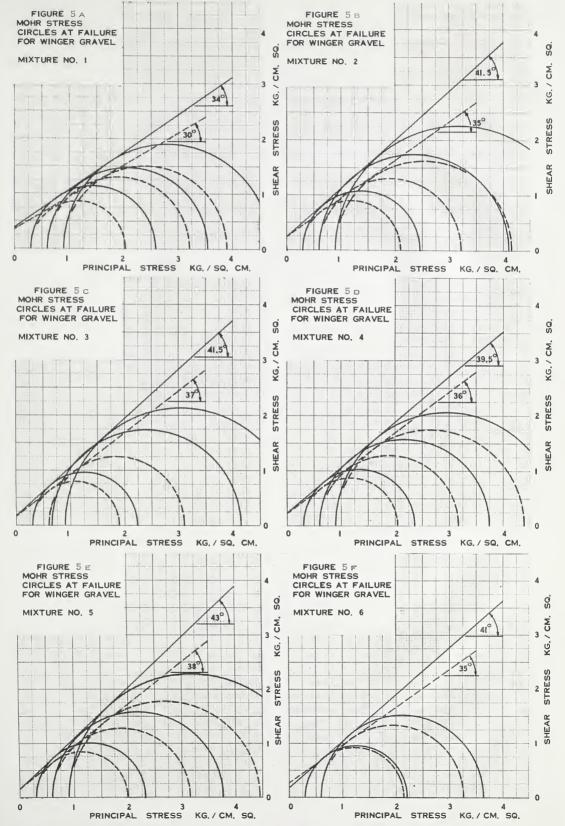
TABLE IV F

RESULTS OF TRIAXIAL TESTS OF WINGER GRAVEL - MIXTURE NO. 6

(3" native gravel crushed to 1" maximum)

Angle of Internal Friction	degrees			41			35
Cohesion	Kgm./sq.cm.			0.15			0.25
Strain at Failure	<i>6</i> 2	77.7	5.49	9.73	8.5	10.5	12.2
Deviator Stress at Failure	Kgm./sq.cm.	1.95	3.04	3.58	1.86	2.68	2.80
Lateral <u>Pressure</u>	Kgm./sq.cm.	0.30	09.0	06.0	0.30	09.0	06.0
Moisture	%	5.2	5.2	5.2	6.5	6.5	6.5
Dry Unit Weight	lbs./cu.ft.	124.5	129.8	125.2	137.6	135.7	139.0
Moist Unit Weight	lbs./cu.ft.	131.0	136.6	131.9	146.4	144.5	148.0

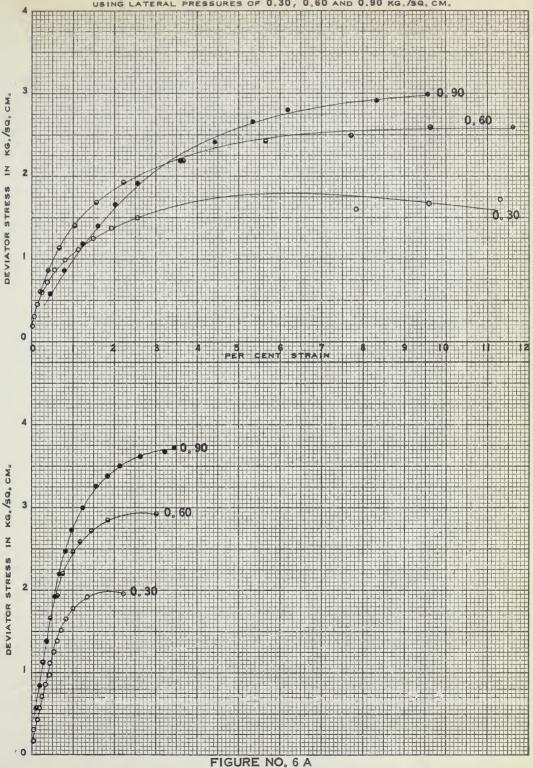




NOTE - SOLID LINES INDICATE MATERIAL COMPACTED AT OPTIMUM MOISTURE CONTENT
DASHED LINES INDICATE MATERIAL COMPACTED AT APPROXIMATELY 6, 3 PER CENT MOISTURE



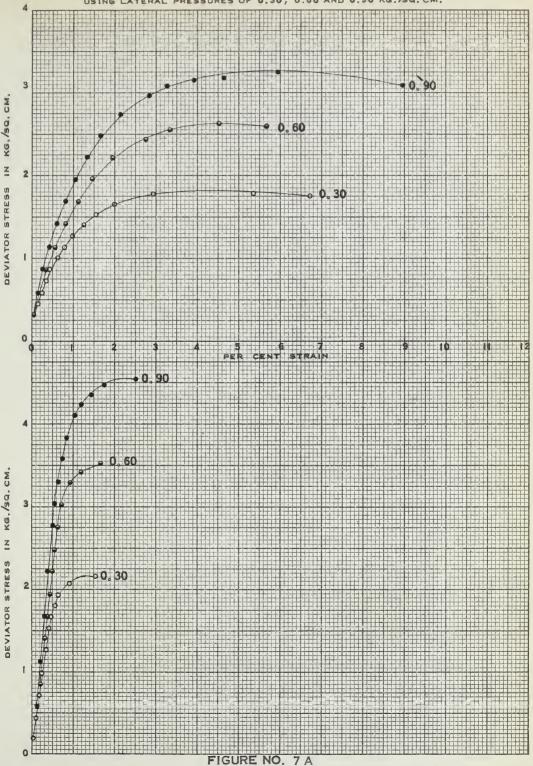
STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO.1 COMPACTED AT A MOISTURE CONTENT 1.2 PER CENT OVER OPTIMUM USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq. CM.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. I COMPACTED AT A MOISTURE CONTENT 0.1 PER CENT BELOW OPTIMUM USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq.cm.



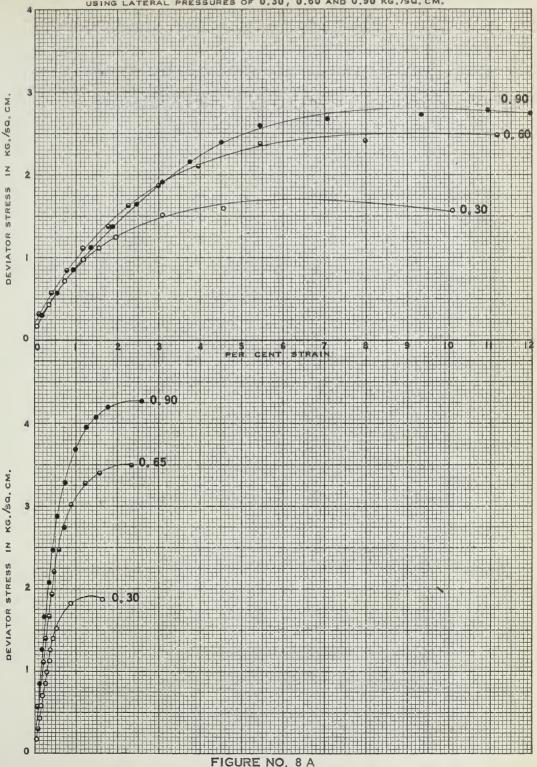
STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 2
COMPACTED AT A MOISTURE CONTENT 0.8 PER CENT ABOVE OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 KG./SQ.CM.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 2
COMPACTED AT A MOISTURE CONTENT 0.5 PER CENT BELOW OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq.cm.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 3
COMPACTED AT A MOISTURE CONTENT (.5 PER CENT ABOVE OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq.cm.



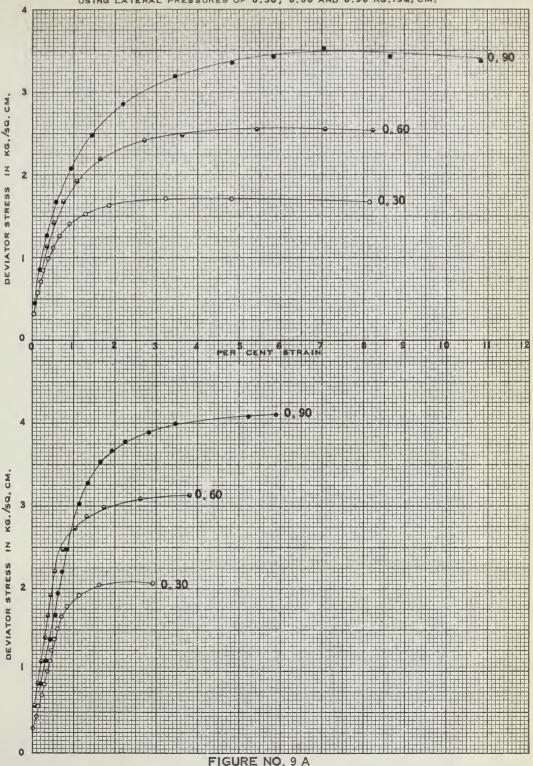
STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 3

COMPACTED AT A MOISTURE CONTENT OF 0.2 PER CENT BELOW OPTIMUM

USING LATERAL PRESSURES OF 0.30, 0.65 AND 0.90 KG./GQ.CM.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 4
COMPACTED AT A MOISTURE CONTENT 0.7 PER CENT ABOVE OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq. CM.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 4

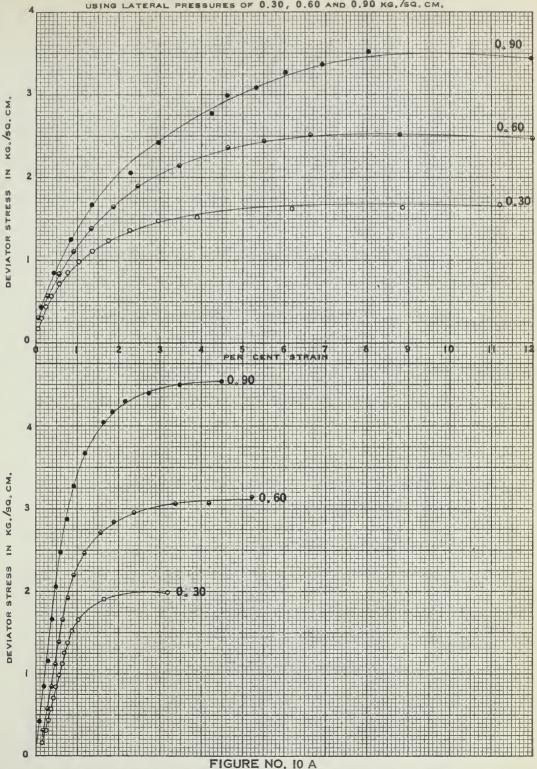
COMPACTED AT OPTIMUM MOISTURE CONTENT

USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 KG./SQ.CM.



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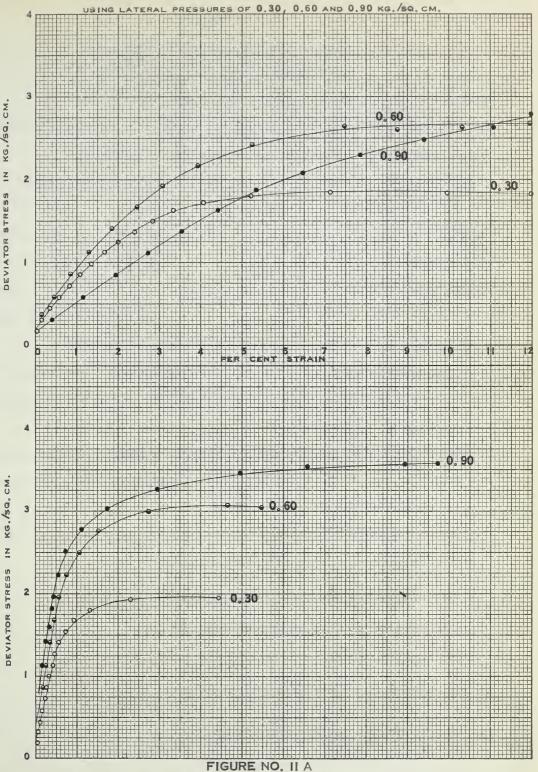
STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 5
COMPACTED AT A MOISTURE CONTENT 0.9 PER CENT ABOVE OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./Sq. CM.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 5
COMPACTED AT A MOISTURE CONTENT 0.3 PER CENT BELOW OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 kg./sq.cm.



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 6 COMPACTED AT A MOISTURE CONTENT 0.9 PER CENT ABOVE OPTIMUM



STRESS STRAIN RELATIONSHIPS FOR WINGER GRAVEL - MIXTURE NO. 6
COMPACTED AT A MOISTURE CONTENT 0.4 PER CENT BELOW OPTIMUM
USING LATERAL PRESSURES OF 0.30, 0.60 AND 0.90 Kg./sq. CM.



#### CHAPTER V

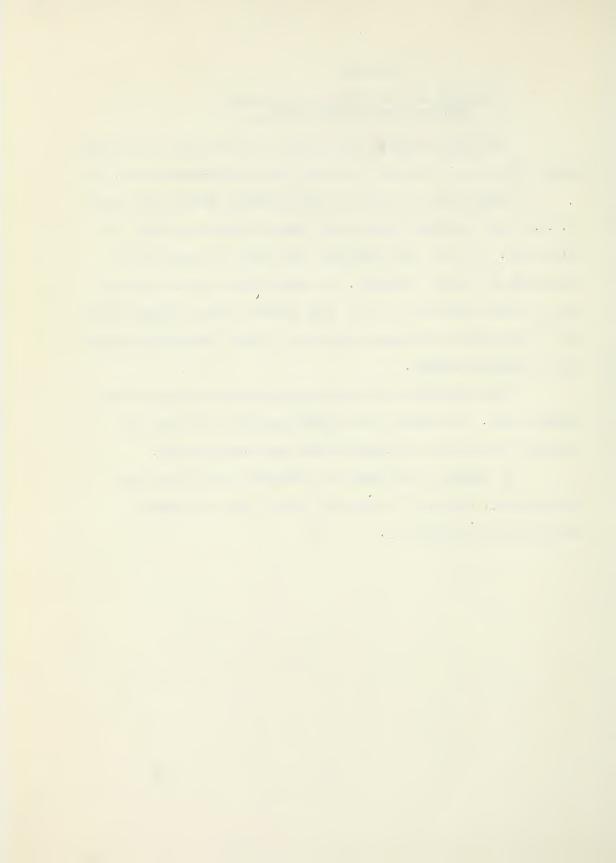
# CORRELATION OF TEST RESULTS WITH VARIOUS METHODS OF BASE COURSE DESIGN

Only three triaxial test methods are used today in the United States and Canada, to evaluate and design base and sub-base courses. (4)

California, in addition to the California Bearing Ratio Tests (C.B.R.), uses a modified triaxial test method known as the Hveem Stability Test. In this test, specimens four inches in diameter by  $2\frac{1}{2}$  inches high are tested triaxially. As the specimen height to diameter ratio of Hveem specimens is 5 to 8, high stresses from end effects would make it impossible to correlate the results of this investigation according to California methods.

Both the Texas and Kansas design methods use the results of triaxial tests. An attempt will be made hereunder to evaluate the results of the current investigation with these design methods.

A summary of the methods of evaluating base and sub-base course quality, currently in use in the United States, is shown in Tables VA and VB respectively.



# TABLE V A

### NUMBER OF STATES USING THE VARIOUS

## MEANS OF EVALUATING BASE COURSE QUALITY

METHOD	NUMBER OF	STATES
Gradation	19	
Soil Constants (Limits)	16	
Abrasion	11	
Experience and Judgment	7	
CBR or CBR modified	5	
Hveem Stabilometer	4	
Unnamed Stability	3	
Hubbard-Field (for bituminous types)	2	
Triaxial Compression	2	
Miscellaneous	11	

## TABLE V B

### NUMBER OF STATES USING THE VARIOUS

### MEANS OF EVALUATING SUB-BASE COURSE QUALITY

METHOD	NUMBER OF STATES
Gradation	20
Soil Constants (Limits)	16
CBR or CBR modified	9
Judgment and Experience	4
Abrasion	3
Granular Materials Specified	3
Group Index	2
Triaxial Compression	2
Drainability	2
Miscellaneous	6

In addition to the above, N. W. McLeod, (5) (6) (7) (8) (9), advocates an in-place plate bearing test to evaluate various components of the pavement structure at their respective natural moisture contents. Further he states, ( (9) item 4(c) ) that it is difficult to compact angular aggregate to as high a density as the more rounded aggregates. Until a vibratory compactor, or other type of new equipment, can compact the angular, rough-surfaced crushed aggregates to as high a density as the more rounded aggregates, and until it can be shown that these relative density characteristics can be retained in service, "the supporting values per unit thickness of base courses made from pit-run and crushed-run gravels, crushed stone, and the various mechanically stabilized aggregates, must be considered essentially equal."

Thus, in the discussion below, an attempt is made to evaluate the results of this investigation using only the triaxial test methods as outlined by the Kansas and Texas State Highway Departments.

TEXAS METHOD (10) (11)

This method may be summarized as follows:

- 1: Specimens are formed in molds 6 in. diameter by 8 in. high at optimum moisture content.
- 2: The specimens are permitted to air dry overnight and then are oven dried at  $140^{\circ}$  for 8 hours.
- 3: The specimens are again allowed to stand overnight and then are allowed to absorb capillary moisture under a surcharge and lateral pressure both of 1 p.s.i. until equilibrium is reached.
- 4: The specimens are then tested triaxially under varying lateral pressures.
- 5: The rupture envelope thus obtained is compared with a chart

indicating various classes of subgrade and flexible base materials, for use in evaluating the thickness of cover material required for various wheel loads. See Figure 12.

Figure 12 illustrates the Texas Highway Department soil classifications obtained from triaxial tests carried out according to the Texas procedure. Rupture lines for mixtures number 1 and number 5, compacted above optimum moisture content, have been plotted on Figure 12 and both indicate a material borderline between Class 3 and Class 4.

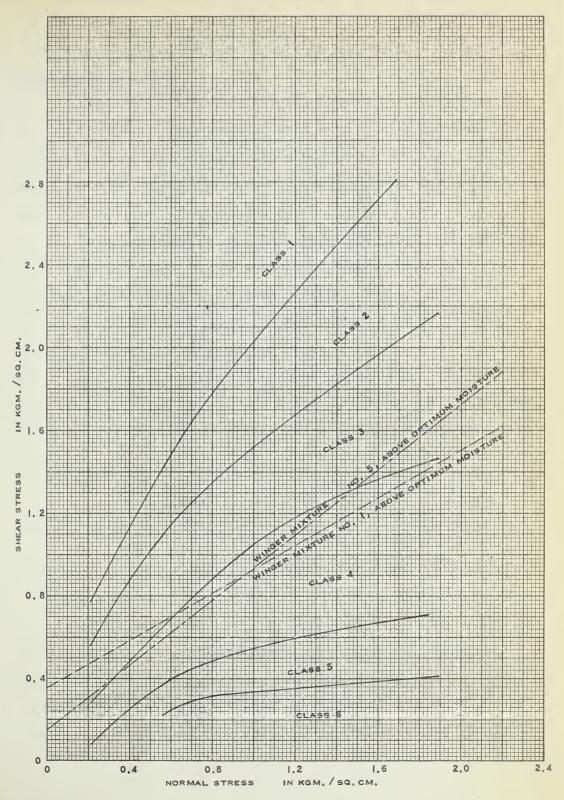
Triaxial test results on a free draining, crushed quarry rock were reported by McDowell (11) and Holtz and Gibbs (12). Holtz and Gibbs, using specimens with a height to diameter ratio of 2 to 1, as was used in the current investigation, found that the angle of internal friction of such an aggregate was 45 degrees, and that there was no cohesion. This would classify such a material as borderline between Classes 3 and 4 according to the Texas Classification. McDowell, using a similar crushed rock, (Lab. No. 49-14-R, pp 5, 9 and 15, (11)), reported test results obtained using the Texas procedure. This procedure, which specifies a specimen height to diameter ratio of 1 1/3 to 1, gave results indicating a Class 1 material.

It is therefore apparent that the results obtained using the two height to diameter ratios are not comparable. The specimens tested according to the Texas procedure, having a height to diameter ratio smaller than the generally accepted minimum of 2 to 1, gave a higher value for the angle of internal friction due to the deviator stresses being greatly influenced by the end restraint upon the specimens.

Thus, while rupture lines for mixtures number 1 and number 5, compacted above optimum moisture content, have been plotted on Figure 12, there is, in fact, no correlation between the rupture lines obtained in



# SOIL CLASSIFICATIONS - TEXAS METHOD OF BASE DESIGN





this investigation and those presented using the Texas triaxial method of design.

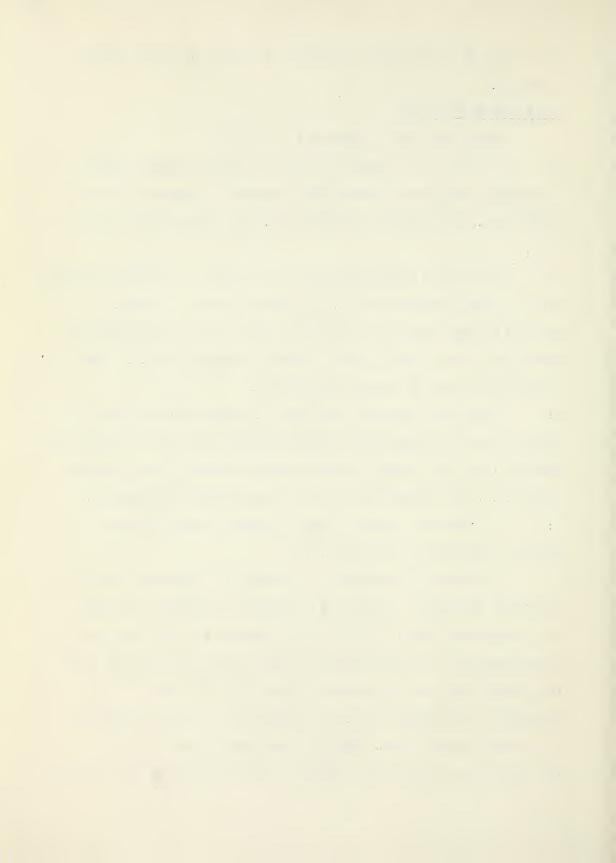
## KANSAS METHOD (13) (14)

This method may be summarized as follows:

- 1: Specimens of subgrade are either cut from undisturbed samples or disturbed samples are obtained from compaction at saturation under a static load. The specimens are normally 2.8 inch diameter by 8 inches high.
- 2: Undisturbed subgrade specimens are tested in a triaxial apparatus under a lateral pressure of 20 p.s.i. after saturation by vacuum.

  Remolded subgrade specimens are allowed to moist cure, are saturated by vacuum, and then are tested under a lateral pressure of 20 p.s.i. The stress strain curve is obtained in each case.
- 3: Base course materials are formed at optimum moisture content in molds 5 inches in diameter by 14 inches high, are saturated by vacuum, and then are tested in a triaxial testing apparatus under a lateral pressure of 20 p.s.i. The stress strain curve is found for the base material.
- 4: The asphaltic surface course is assumed to have a minimum modulus of deformation of 15,000 p.s.i.

The modulus of deformation is defined as the deviator stress divided by the strain. In the case of asphaltic materials, a straight line relationship exists until failure is imminent and thus the modulus of deformation is the tangent modulus. This is also the case with clean well graded base course aggregates as specified by the Kansas Highway Department. The subgrade, however, usually has no straight line portion to the stress strain curve. Thus the secant modulus, which is the deviator stress at any strain, divided by that strain, is used for subgrade



soils and is not a constant value for any soil in a plastic state.

5: Graphical solutions from charts are then used to solve the equation:

$$T = \left[ -\sqrt{\left(\frac{3 \operatorname{Pm} n}{2 \operatorname{\pi} \operatorname{CS}}\right)^2 - a^2} \right] \left[ \sqrt[3]{\frac{C}{C_P}} \right]$$

where T = thickness of asphaltic pavement required in inches.

Cp= modulus of deformation of pavement or surface course
 in p.s.i.

C = modulus of deformation of subgrade in p.s.i.

P = basic wheel load in lbs.

m = traffic coefficient based on volume of traffic.

n = saturation coefficient based on rainfall.

a = radius of area of tire contact corresponding to Pm.

S = permitted deflection of surface.

Kansas use a maximum value for S of 0.1 inch. The values for m and n for the highway where the Winger pit was used were found from gross loads allowable and from weather data to be I and 0.6 respectively.

The evaluation of the mixtures of Winger gravel was obtained from the stress strain curves for both optimum and over optimum moisture condition and a lateral pressure of 0.9 Kgm./sq.cm. (12.8 lbs./sq.in). This lateral pressure is the practical maximum obtainable using vacuum triaxial methods, and would not, in fact, give values of thickness of surfacing required according to the Kansas method where a lateral pressure of 20 lbs./sq.in. is used. It was considered, however, that the thickness values obtained might serve to produce a qualitative evaluation of the base material. The results obtained are as outlined in Table VI.

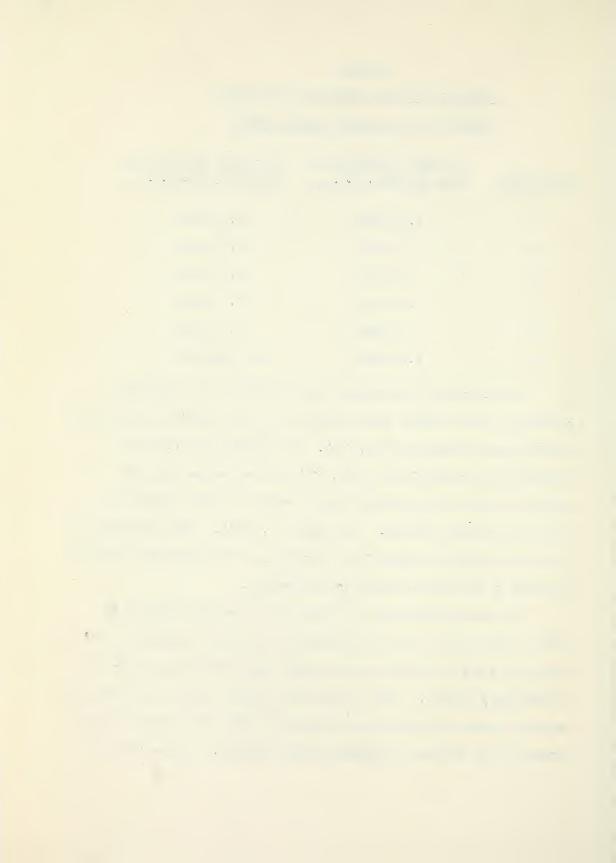
ASPHALTIC PAVEMENT THICKNESS REQUIREMENTS

ACCORDING TO THE KANSAS DESIGN METHODS

MIXTURE NO.		REQUIRED FOR OPT. M.C.	THICKNESS REQUIRED FOR BASE OVER OPT. M.C.
1	2.0	inches	6.2 inches
2	0	inches	3.2 inches
3	0	inches	6.9 inches
4	1.6	inches	3.0 inches
5	0	inches	4.4 inches
6	2.3	inches	not evaluated

The thickness requirements shown in Table VI were computed according to the original Kansas design curves and traffic and saturation coefficients published in 1947, (14). The traffic and saturation coefficients were modified in 1953, (25), but values for required thickness using to the modified factors varied from the original by only plus or minus one inch. (See Figure 5, (25)). Thus the thickness requirements shown in Table VI are relatively, if not absolutely, correct according to the present Kansas design practice.

The major differences in thicknesses of pavement required as shown in Table VI are due to the variation in moisture content, in the most part, and to evaluating stress strain curves which may, or may not be absolutely correct. Small variations in these curves, even though the failure stresses and strains may be equal for each curve result in large changes in the thickness of surface course required. As the shapes of

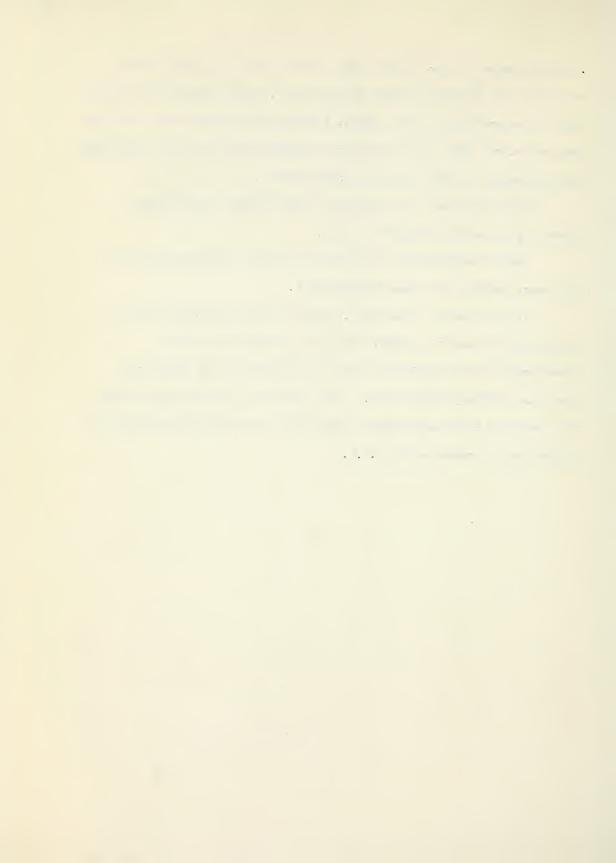


the experimental stress strain curves are dependent upon such factors as density and moisture content of the sample, proper knitting and alignment of the particles in the sample, and accurate seating of the loading head and strain dial, it is felt that a proper evaluation of the aggregate mixtures cannot be made using the Kansas method.

The variations in the shapes of experimental stress strain curves may be noted in Figures 6 to 11.

Sample computations of pavement thickness requirements, using the Kansas method, are shown in Appendix A.

It would appear, therefore, that no valid correlation can be established between the triaxial tests as carried out in this investigation and the triaxial tests as performed by the Kansas and Texas State Highway Departments. It is thus not possible to correlate the results of this investigation with base course design procedures in present use in Canada or the U.S.A.



### CHAPTER VI

### DISCUSSION AND CONCLUSIONS

The results obtained in this part of the investigation indicate that the strength characteristics of a native gravel, which has an excess of low plastic fines, can be improved in two ways, namely,

- 1) By crushing to an optimum maximum particle size.
- 2) By washing the aggregate to remove a portion of the minus #200 sieve material.

It may be noted from Figure 5 that the angle of internal friction for mixtures 2 to 6 inclusive, in a wet condition, were all higher then that for the original material, mixture No. 1, compacted at optimum moisture content. It may also be noted that the value for cohesion varied only between 0.15 and 0.40 kgm. / sq. cm. As these values are within the degree of accuracy of the test used, it may be assumed that crushing or removing fines from this material had little effect upon the value for cohesion.

An assumption might be made that as the angle of internal friction of the original material at optimum moisture content, 34 degrees, was sufficiently high to prevent failure under the imposed highway construction loads, and as all other mixtures in a wet condition had angles of internal friction greater than 34 degrees, any of these other mixtures in a wet condition would have performed satisfactorily under the loads. This assumption, however, cannot be made. From Figures 6 to 11, it may be noted that the strain required to develop this angle of internal friction for mixtures 2 to 6 inclusive, in a wet condition was about 2.5 times that required to develop the angle of internal friction for mixture 1 at optimum moisture content. Thus if failure



were taken to mean an excessive deformation of a pavement at a given load, or repetition of loads, then it is possible that "failure" may have in fact taken place with mixtures 2 to 6 inclusive, in a wet condition, before the maximum load had been applied.

Table VII shows the deviator stress required to produce the same strain for mixtures 1 to 6 in a wet condition, as was required at failure for mixture number 1 at optimum moisture content. It may be seen that the deviator stress was, in all cases, much lower for the wet material than it was for the original material at optimum moisture content, and was in many cases lower for mixtures 2 to 6 in a wet state than it was for the original material in a wet state.

Whether or not these large strains would be required to develop the potential angle of internal friction within the crushed or washed aggregate, in a wet condition, under field conditions is a moot question. The main factor which might influence this is that in the field there would be much less lateral restraint during compaction and therefore it is possible that a better particle arrangement might be effected.

TABLE VII

DEVIATOR STRESS REQUIRED TO PRODUCE THE FAILURE STRAIN
OF MIXTURE NO. 1 COMPACTED AT OPTIMUM MOISTURE CONTENT

Mixture Number	Lateral <u>Pressure</u> Kgm/sq. cm.	Strain %	Deviator Stress at Given Strain Kgm/sq. cm.
1 (opt.)	0.30	2.14	1.96
1 (wet)	11	11	1.41
2 (wet)	11	11	1.68
3 (wet)	11	11	1.30
4 (wet)	11	11	1.66
5 (wet)	11	11	1.32
6 (wet)	11	11	1.30



TABLE VII (Continued)

Mixture number	Lateral <u>Pressure</u> Kgm/sq.cm.	Strain %	Deviator Stress at Given Strain Kgm/sq.cm.
1 (opt.) 1 (wet) 2 (wet) 3 (wet) 4 (wet) 5 (wet) 6 (wet)	0.60	3.30 "" "" ""	2.94 2.16 2.55 1.96 2.48 2.20 2.02
1 (Opt.) 1 (wet) 2 (wet) 3 (wet) 4 (wet) 5 (wet) 6 (wet)	0.90 " " " " " "	3.47	3.73 2.23 3.10 2.05 3.19 2.60 1.35

It might also be argued that as mixtures 2 and 3 contained

less minus #200 sieve material than the original mixture, the migration

of capillary moisture in these mixtures would be less than for the original

material. This should mean that there would less moisture in the

granular base to cause failure. It is felt, however, that there was

not a sufficient reduction in the minus #200 sieve material of mixtures

2 and 3 to materially reduce the migration of capillary moisture within such

mixtures when used as base courses. This was evidenced by the fact that the

permeability of mixture 3 was found to be very low.

As the loss of stability is due mainly to a reduction in intergranular stresses, brought about by an increase in pore water pressure under a load, only those base course materials which are extremely permeable show no loss in stability with an increase in moisture content (12).

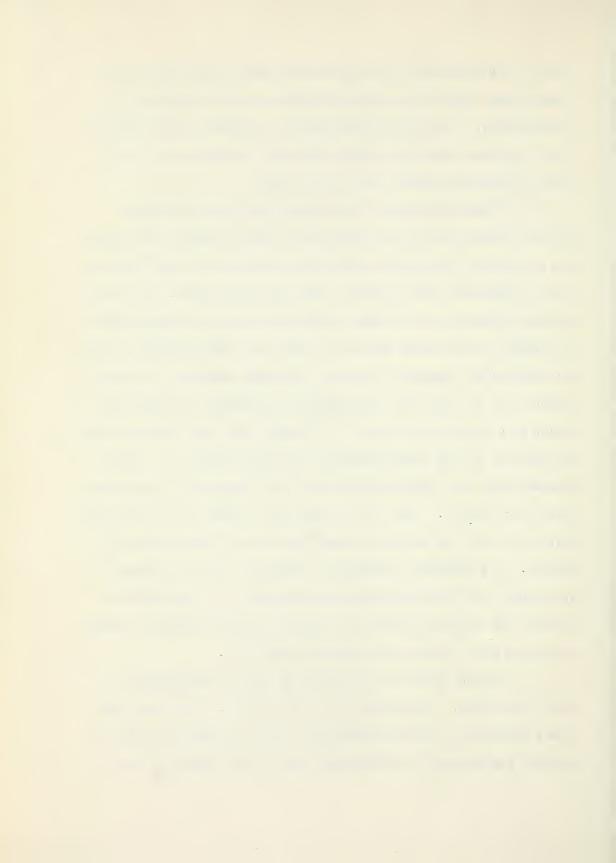
On the other hand, nearly saturated base course materials which contain an excess of plastic fines are so slow draining that there is insufficient



time for the dissipation of the excess pore water pressure during the loading time, which, in the case of highways, may be considered to be instantaneous. As, in this investigation, an excess of fines existed in all samples, there was a marked reduction in stability with an increase in moisture content noted in all cases.

Where the material was compacted and tested at optimum moisture content, there were sufficient air voids present in the specimen to provide a compressible medium which permitted the rapid dissipation of excess pore water pressure under the loads applied. The intergranular stresses were therefore not greatly reduced and higher angles of internal friction were noted for crushed and cleaned material. Where the material was compacted closer to a saturated condition, sufficient compressible air voids were not available to adequately dissipate the excess pore water pressure and, it is thought, the higher stresses were not achieved at high strains because of the high strains, but simply because there was a longer time available for dissipation of the excess pore water pressure. Thus the intergranular stresses were not as fully developed as was the case for the same materials at optimum moisture The developed intergranular stresses at failure, however, were greater for the crushed and washed aggregate in a wet condition than for the original aggregate in a similar condition and thus it might be assumed that crushing and washing are beneficial.

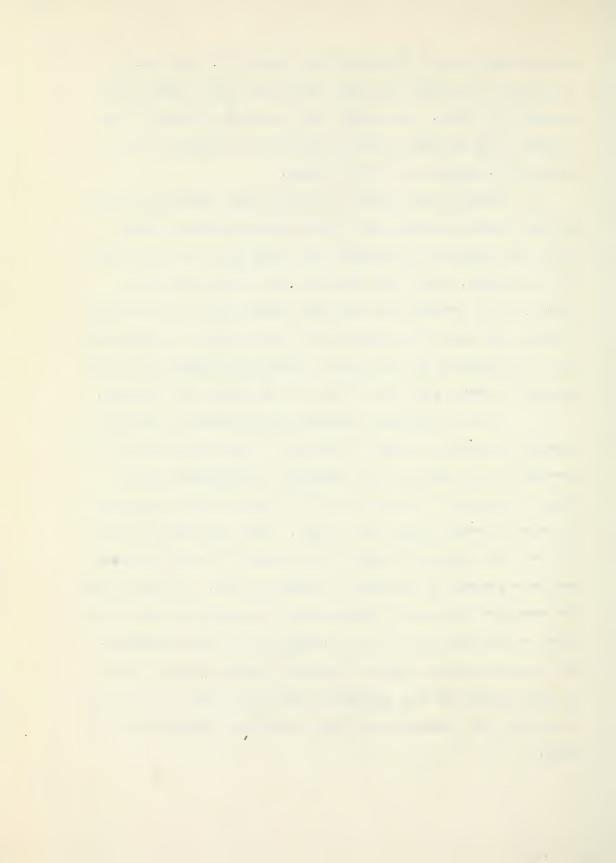
Several factors were noted which tend to substantiate the above conclusions. The permeability of mixture No. 3, which had the lowest percentage of minus #200 material, was so low that in trying to saturate the specimen by allowing the bottom of the specimen access to



deaired distilled water while applying a vacuum of 0.90 kgm/ sq. cm. to the top of the sample, the water had advanced only 4 inches up the specimen in 72 hours. At the same time the vacuum had dried the top 4 inches of the specimen to such an extent that it appeared, to all intents and purposes, as an air dry sample.

Before it was decided to line the rubber membrane with felt, and thus provide a drainage path for the excess pore water pressure within the specimens, the specimens would slump under little more than their own weight. Under field conditions this drainage path would normally not be available and thus little benefit would be derived from crushing, and benefit from washing would become apparent only when washing of the aggregate was sufficient to increase the permeability of the aggregate to such a point where it would be essentially free draining.

It may be concluded, therefore, that crushing or washing an aggregate containing an excess of low plastic fines may indicate an improvement in the stability of the aggregate, as determined by an increase in the angle of internal friction at failure when the aggregate is tested by vacuum triaxial test methods. This improvement is effective only when the rate of loading is sufficiently slow that the excess pore water pressure is dissipated as loading proceeds. As highway loads are repetitive and virtually instantaneous, the excess pore water pressure cannot be dissipated due to the low permeability of such an aggregate. The potential increase in angle of internal friction, therefore, cannot be fully utilized and thus aggregates containing an excess of low plastic fines remain very susceptible to loss of stability at high moisture contents.



As triaxial test moisture contents of the Winger gravel did not approach those at which failure occurred in the field, see Figure A, it is assumed that failure occurred at higher degrees of saturation than those obtained in the laboratory. No record of field density tests exists, and thus this assumption cannot be substantiated. However, if a field density of 132 lbs./ cu.ft. had been obtained, 100 per cent saturation occurred at a moisture content of 10 per cent.



## PART B

AN INVESTIGATION INTO THE EFFECT OF PORTLAND
CEMENT AND LIME FLY-ASH ADMIXTURES UPON THE
PLASTICITY CHARACTERISTICS OF FINES FROM
CRAWFORD PIT GRAVEL WHICH HAD AN EXCESS OF
MEDIUM PLASTIC FINES



#### CHAPTER VII

### CLASSIFICATION AND ANALYSIS OF MATERIALS INVESTIGATED

The source of the gravel used in this part of the investigation was the Crawford Pit (SW 33-36-20-4) near Stettler, Alberta. A visual examination of the native gravel, as well as grading and Atterberg Limit tests, showed that the material corresponded to the GF soil group of the Casagrande Airfield Classification system (1), and to an A-2-6 soil with a Group Index value of 0 as determined by the AASHO Classification system (2).

Table VIII shows the average results of twelve sieve analysis and Atterberg Limit tests carried out by the Testing Laboratory of the Alberta Department of Highways and reported by Clark (3).

TABLE VIII

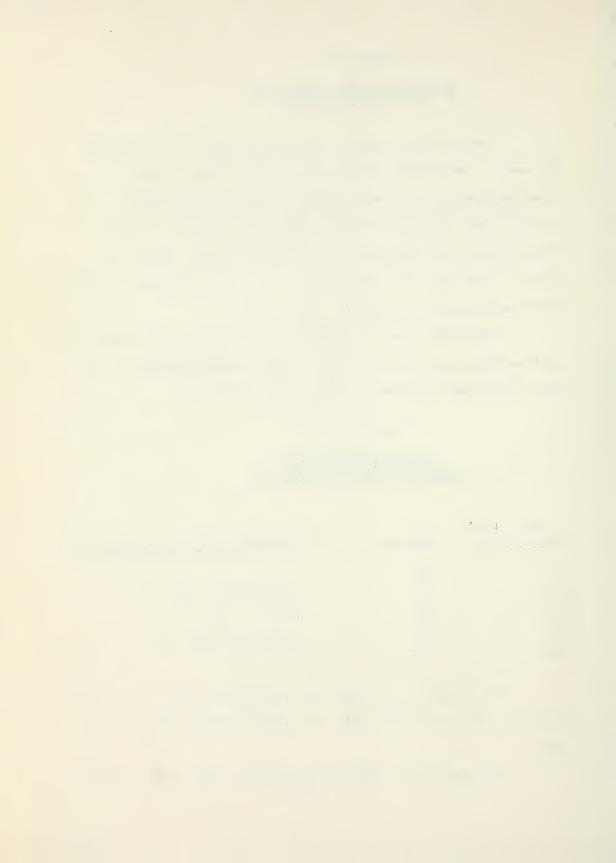
MECHANICAL ANALYSIS AND

PLASTICITY TESTS - CRAWFORD PIT

Oversize (+ 3") Sieve	6% % Passing	Atterberg Limits on - #40 Portion
3"	100	
1211	90	Liquid Limit 35.8
3/4"	73	
#4	40	Plastic Limit 19.5
<i>‡</i> 10	25	
#40	14	Plasticity Index 16.3
#200	8.9.	

The analyses of the quick lime and fly-ash used in this investigation were reported by Clark (3). The cement used was normal portland, type I.

The actual sieve analysis and Atterberg Limits of the Crawford



Aggregate used in this part of the investigation were as follows:

Port	ion
3" 100 1½" 93 Liqu	id Limit 38.5
3/4" 75 #4 43 Plas	tic Limit 20.3
#10 29 Plas #40 17 #200 11.2	ticity Index 18.2



#### CHAPTER VIII

### APPARATUS AND PROCEDURES USED

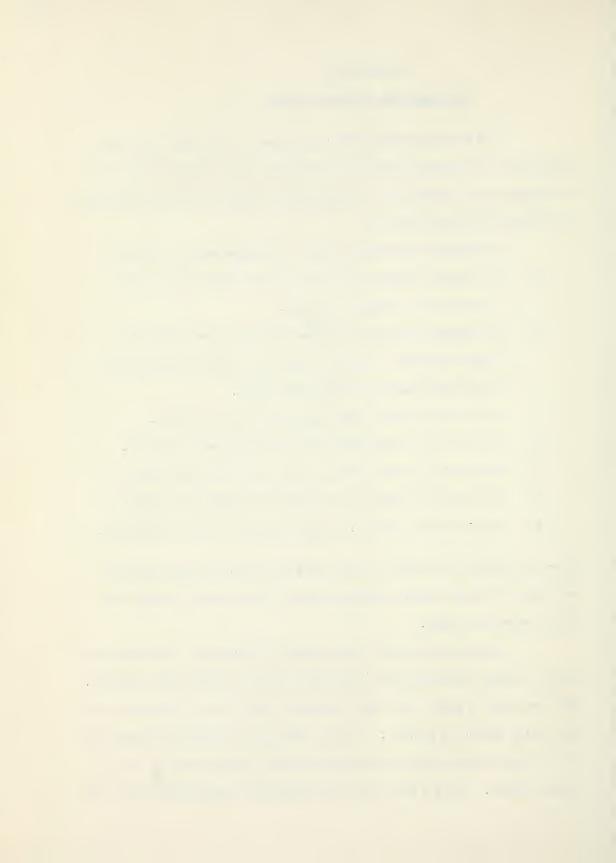
The Atterberg Limit Tests performed on the minus #40 sieve portion of the Crawford gravel, and mixtures of the Crawford fines and additives, were carried out as recommended by Lambe (16) for determining the Liquid and Plastic Limits.

The Liquid and Plastic limits determined were as follows:

- a) On original Crawford pit fines (minus #40 sieve portion)5 hours after mixing with water.
- b) On original Crawford pit fines with 2% normal portland cement additive, 1 hour, 6 hours, 26 hours, 7 days and 28 days after mixing with distilled water.
- c) As for (b) with 5% normal portland cement additive.
- d) As for (b) but with 8% normal portland cement additive.
- e) As for (b) but with 1% quicklime and 2% fly-ash additive.
- f) As for (b) but with 2% quicklime and 4% fly-ash additive.
- g) As for (b) but with 3.5% quicklime and 7% fly-ash additive.

Where an addition of cement or lime fly-ash was made, these additives were mixed into the Crawford fines when both were air dry, before distilled water was added.

Sufficient material, approximately 1200 grams, was mixed with water to carry out each of the limit tests at all curing times required. This was done in order that there would be no variation in material from one curing period to another. In all cases, the curing was accomplished in a closed container and at a moisture content between the plastic and liquid limits. When a test was to be performed, approximately 200 grams

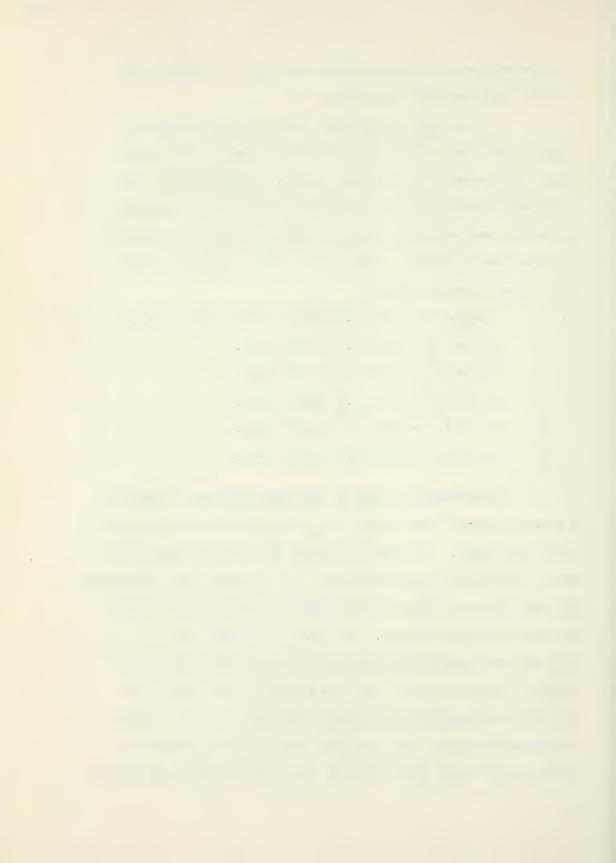


was removed from the container, mixed with water to a smooth paste and the limits were then carried out.

It was noted that the major reduction in the plasticity index of the fines was due to an immediate increase in the plastic limit upon the addition of portland cement. Further plastic limit tests were therefore carried out one hour after mixing to determine the effect upon the plastic limit produced by various percentages of portland cement additive. These plastic limit tests were carried out on the following mixtures:

- a) Crawford fines with 0.5% normal portland cement added.
- b) As for (a) but with 1.0% cement added.
- c) As for (a) but with 1.5% cement added.
- d) As for (a) but with 2.5% cement added.
- e) As for (a) but with 6.5% cement added.
- f) As for (a) but with 9.0% cement added.

From Figure 15 it may be seen that there was no immediate increase in plastic limit larger than that produced by the addition of 3 per cent cement. In order to estimate the amount of cement to be used in forming the triaxial specimens, it was assumed that the quantity of cement required by the minus #40 sieve portion of the gravel was 3 per cent as determined above. The quantity of cement required by the plus #40 sieve portion was determined by assuming that the ratio of weight of cement to surface area of aggregate was the same for the plus #40 sieve portion as for the minus #40 sieve portion. Surface areas were determined using the sieve analysis of the aggregate and surface area factors as given by the California Department of Highways.



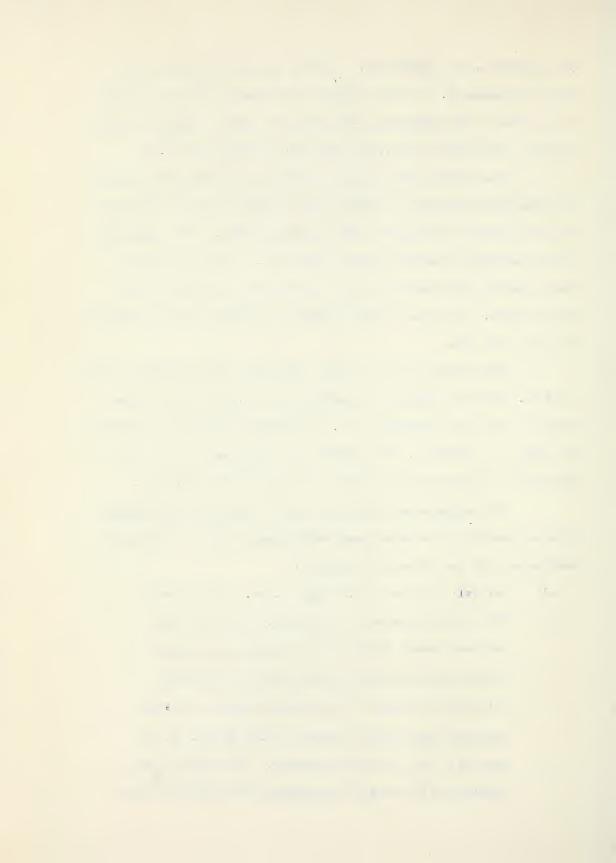
(See Figure No. 18, Appendix A). Details of the calculations are shown in Appendix A. In this instance, the cement required by weight of dry minus 3 inch aggregate, which was to be used in forming triaxial specimens, was found to be 0.45%, which was rounded off to 0.5%.

The molding water content to be used in forming the triaxial specimens was determined by carrying out a compaction test on the minus #4 sieve portion of the gravel with the cement added. The compactive effort was half of standard proctor compaction. The percentage of cement used for the compaction test was determined using the surface area as above. The plus #4 sieve gravel was assumed to have an absorption of 1 per cent.

The weights of each of the 9 aggregate sizes required to form a 240 lb. batch for forming the specimen were determined in the same fashion as those for the Winger Pit. An attempt was made to reproduce the actual pit gradation. The batches for the compaction test were computed in a similar fashion using only minus #4 sieve material.

The apparatus and procedures used to carry out the triaxial tests on Crawford pit material were as discussed in part A of this investigation with the following exceptions:

- a) Lateral pressure of 0.30 kgm/ sq. cm. only was used.
- b) The triaxial specimen containing 0.5 per cent normal portland cement, which was to be tested at a moisture content above optimum, was saturated in 12 hours by allowing the bottom of the specimen access to de-aired distilled water while a vacuum of 0.90 kgm/sq. cm. was applied to the top of the specimen. This was the only specimen of the entire investigation where this procedure



was successful.

c) The cement was added to the dry fines and mixed thoroughly before the entire mixture was mixed, water added, and then remixed. This was to insure that the cement was well distributed throughout the entire specimen.



# CHAPTER IX

# TESTING PROGRAMME RESULTS:

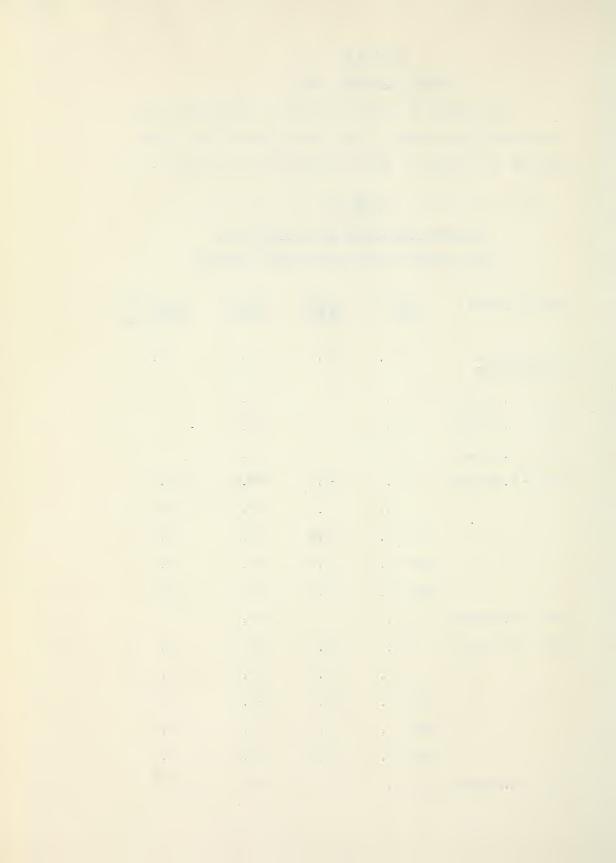
The results of testing programme on the plasticity of the minus #40 sieve portion of the Crawford gravel with various additives are as shown in Table IX and Figures 12, 14 and 15.

TABLE IX

PLASTICITY CHARACTERISTICS OF MINUS #40

SIEVE CRAWFORD GRAVEL WITH VARIOUS ADDITIVES

MATERIAL TESTED	CURING TIME	LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
Crawford fines (no additives)	5 hrs.	38.5	20.3	18.2
Fines / 0.5%Cement	1 hr.		21.9	nig
Fines / 1.0%Cement	1 hr.		24.7	949
Fines / 1.5%Cement	1 hr.	20	26.4	449
Fines / 2.0%Cement	1 hr.	42.0	28.5	14.5
	6 hrs.	38.7	28.5	10.2
	26 hrs.	38.8	29.3	9.5
	168 hrs.	39.9	30.1	9.8
	680 hrs.	40.0	29.4	10.6
Fines / 2.5%Cement	1 hr.		27.6	an
Fines / 5% Cement	1 hr.	35.4	29.1	6.3
	6 hrs.	40.7	33.1	7.6
	36 hrs.	40.2	32.7	7.5
	196 hrs.	43.1	34.1	9.0
	678 hrs.	45.8	39.1	6.7
Fines / 6.5%Cement	1 hr.	40	29.1	-



MATERIAL TESTED	CURING TIME	LIQUID	PLASTIC LIMIT	PLASTICITY ÍNDEX
Fines # 8.0% Cement	1 hr.	35.6	29.0	6.6
	6 hrs.	37.9	30.0	7.9
	32½ hrs.	39.8	32.8	7.0
	199 hrs.	43.7	37.4	6.3
	690 hrs.	45.6	39.8	5.8
Fines # 9.0% Cement	1 hr.	**	28.1	-
Fines / 1% Lime	1 hr.	36.5	30.7	5.8
/ 2% Fly-ash	6 hrs.	34.6	26.8	7.8
	24 hrs.	36.4	29.6	6.8
	193 hrs.	36.8	26.5	10.3
	866 hrs.	40.0	28.4	11.6
Fines # 2% Lime	1 hr.	30.9	24.3	6.6
≠ 4% Fly-ash	6 hrs.	30.8	24.0	6.8
	24 hrs.	33.0	25.7	7.3
	193 hrs.	36.2	26.8	9.4
	866 hrs.	39.6	33,9	5.7
Fines # 3.5% Lime	1 hr.	32.7	27.7	5.0
7% Fly-ash	6 hrs.	34.8	26.8	8.0
	24 hrs.	31.1	24.5	6.6
	196½ hrs.	35.0	27.4	7.6
	866 hrs.	39.1	30.3	8.8

It was noted that when cement was used as an additive, there was an immediate reduction in plasticity index, due in the most part, to an increase in plastic limit. A plot of plastic limit versus percent of cement added is shown in Figure 15.

\* ж Ac. \* . . . . . 1 ~ . . . . . ., \* \* . and the state of t All data sheets for this part of the investigation are contained in Appendix C.

Triaxial compression test results for the Crawford gravel are shown in Table X and Figure 16.



TABLE X

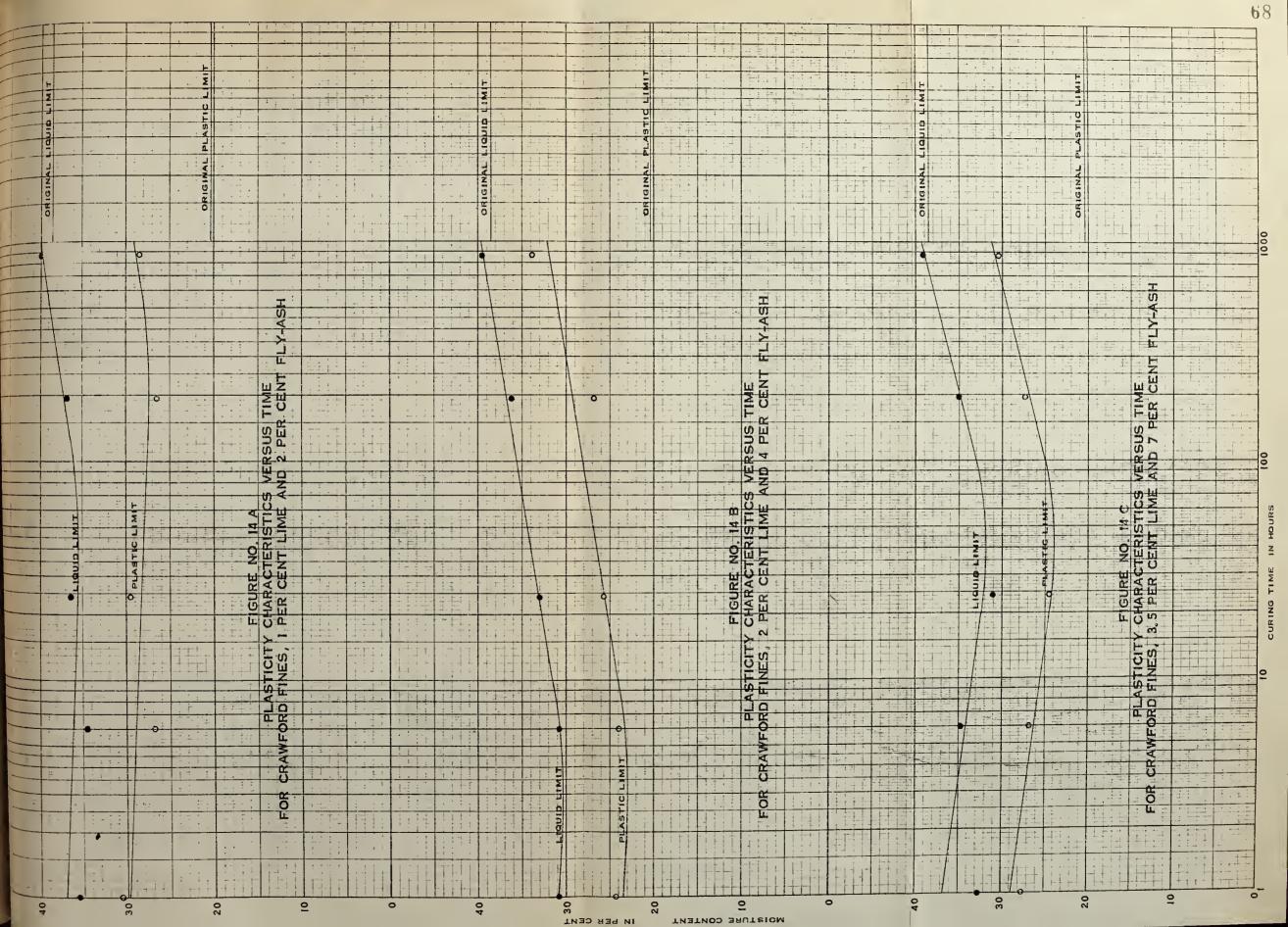
TRIAXIAL COMPRESSION TEST RESULTS OF CRAWFORD GRAVEL (-3")

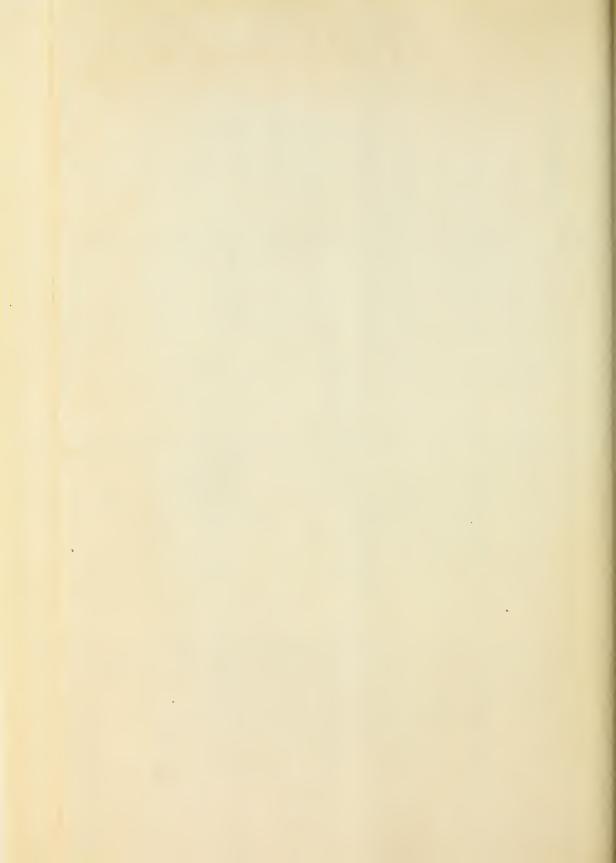
\* Average of 6 tests reported by Clark (3)

\*\* One test reported by Clark

\*\*\* Average of 2 tests reported by Clark







# PLASTIC LIMIT VERSUS PER CENT CEMENT FOR CRAWFORD FINES

CURING TIME | HOUR

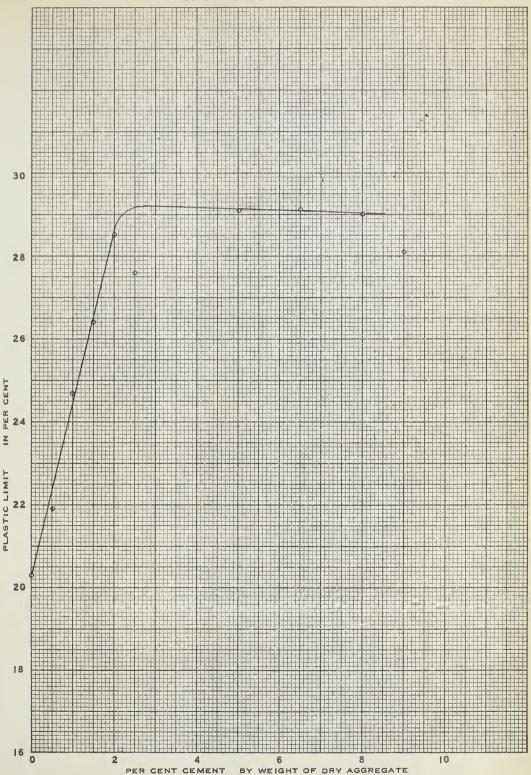
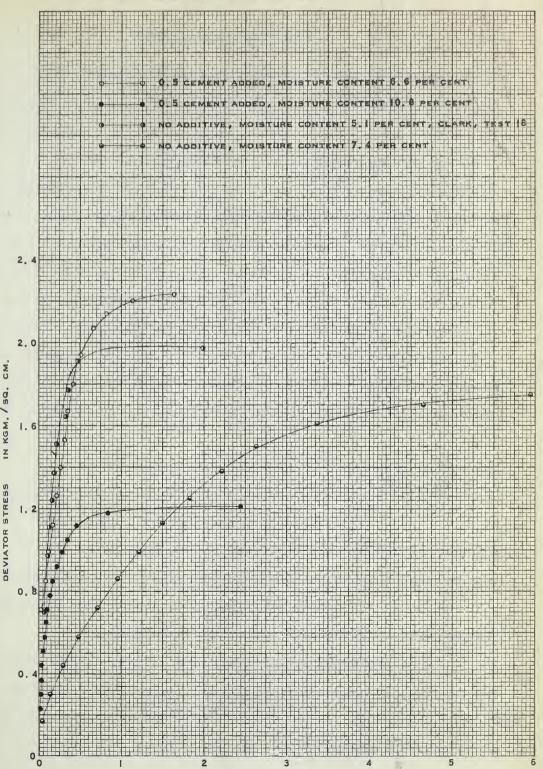


FIGURE NO. 15



STRESS STRAIN CHARACTERISTICS FOR CRAWFORD PIT GRAVEL AT A LATERAL PRESSURE OF 0, 30 KGM. / SQ. CM.



STRAIN

IN PER CENT



#### CHAPTER X

## DISCUSSION AND CONCLUSIONS

A summary of the results of this portion of the investigation (Figures 13 to 16 and Tables IX and X) permit the following conclusions to be drawn:

When portland cement was used as an additive there was an immediate reduction in the plasticity index of the gravel fines made up of a slight decrease in the liquid limit and a large increase in the plastic limit. The plasticity index thereafter remained a constant as curing took place, the value of the constant depending to a small degree upon the quantity of cement used over 3%. Below a minimum amount of cement, in this case 3% as determined by plastic limit tests and as illustrated in Figure 15, the value of the plasticity index was dependent upon the quantity of cement added. A definite relationship between the percentage of cement and the plastic limit was noted for quantities of cement below 3%.

As curing took place, after the initial increase in plastic limit, both the liquid and plastic limits increased at a constant rate which was dependent upon the quantity of cement used.

It may be noted that after 1,000 hours the plastic limit of the fines was approximately the same value as the original liquid of the untreated fines, when 5% and 8% cement was added.

When 0.5% cement was added to the triaxial specimens, definite changes in the strength characteristics of the gravel were noted. In the case of the gravel compacted near optimum moisture content, the stability of the gravel, as measured by the deviator stress, was 20% greater than that of untreated native gravel at the same lateral pressure. This was true

even though the gravel with the cement contained almost 50% more water than that of the untreated gravel. The strains at failure were virtually identical in both cases.

The permeability of the gravel with 0.5% cement was increased to such an extent that of all the triaxial tests carried out, both for the Winger and Crawford gravels, this material was the only one which could be saturated by vacuum in 12 hours. This accounted for the high moisture content used for testing.

The addition of 0.5% of cement to the triaxial specimen, however, did not prevent a large loss of stability due to increased moisture content. At strains of less than 1% much higher stabilities were noted for the treated gravel at 10.8% moisture, than for the untreated gravel at 7.4% moisture. Thus for strains of less than 1%, higher stabilities were recorded for treated gravel, both near optimum moisture content and in a wet condition, than for untreated gravel in similar moisture conditions. (See Figure 16).

Where lime and fly-ash were used as additives, an immediate decrease in plasticity index of the fines was also observed (Figure 14). This was made up both by an increase in plastic limit and a decrease in liquid limit. The initial increase in the plastic limit of the fines plus the increase in plastic limit with time is likely the reason for the "drying" effect of the additive as noted by others (17). It would also explain the need for a higher optimum moisture content for compaction (21) (22) (3).

The time effect upon the plasticity characteristics produced by lime and fly-ash was an initial decrease in both the liquid and plastic limits from those obtained one hour after mixing. As curing started, however,



both the liquid and plastic limits increased in a similar fashion to that noted where portland cement was used as an additive. (See Figure 14).



## CHAPTER XI

## DISCUSSION OF TEST RESULTS

When a load is applied to a saturated soil, the total stress within the soil is made up of the neutral stress, or that portion of total stress carried by the pore water, and the effective stress, that portion of the total stress carried by the soil skeleton at the points of contact of the soil particles. When a granular, free draining soil is loaded, the excess pore water pressure is quickly dissipated by migration of the water from the pores, and the neutral stress within the specimen becomes zero. The total stress, total load divided by the area over which this load acts, then is equal to the resulting effective stress.

When a fine grained saturated soil is subjected to rapid loading, the neutral stress cannot be dissipated rapidly due to the low permeability of the soil. This results in the effective stress being lower than the total stress by the amount of the existing neutral stress. The shearing strength of a soil is the product of the effective stresses within the soil, and the coefficient of internal friction of the soil. Therefore the shearing resistance of a fine grained soil tested under slow test conditions in which the neutral stresses are dissipated by drainage after each increment of load, is higher than that of the same soil tested under quick test conditions. Under quick test conditions, the specimen is not permitted to drain during loading and thus there is no dissipation of the neutral stress.

In the case of partially saturated fine grained soils tested under quick test conditions, the neutral stress is partially dissipated by compression of the air voids with a resulting volume reduction in the specimen. The reduction of the neutral stress is inversely proportional

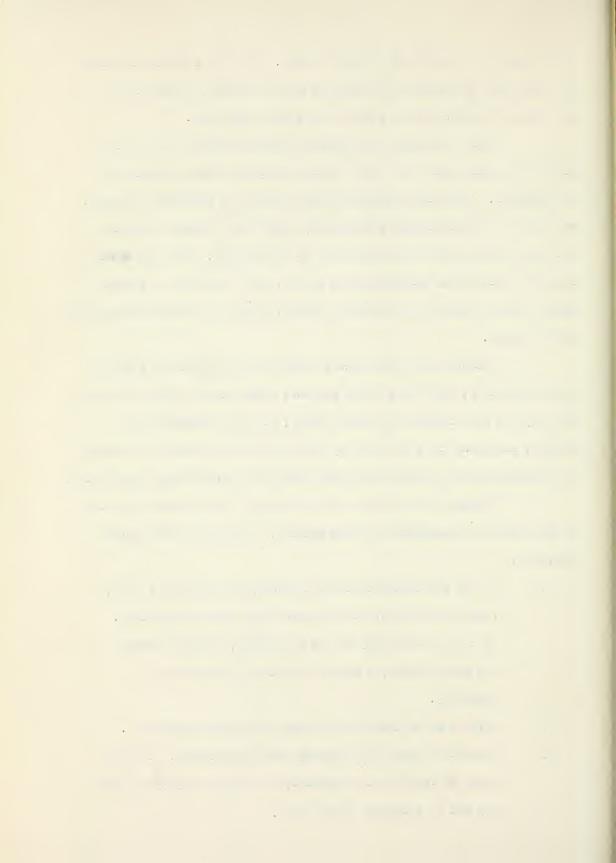
to the degree of saturation of the specimen. Thus the shearing strength of a partially saturated fine grained soil is inversely proportional to the moisture content of the soil at any given void ratio.

Both the Winger and Crawford gravels exhibited properties of a fine grained soil due to the excess of plastic fines contained in both gravels. The vacuum triaxial tests carried out permitted drainage, but the rate of testing was sufficiently rapid that drainage could not take place due to the low permeability of the gravels. Thus the main cause for decrease in stability of a gravel, with an excess of plastic fines, with an increase in moisture content, is due to the low permeability of the gravel.

Because the plastic fines adhere to the surface of sand and gravel particles, and because fine screens, which might be used to screen the clay and silt fraction from the gravel, are very expensive and fragile, screening the silt and clay from the sand and gravel to increase the permeability of the sand and gravel would be expensive and impractical.

Washing the sand and gravel to remove the clay and silt would be one method of increasing the permeability. This method has several drawbacks:

- Due to the inefficiency of currently used washing plants, sand is washed out of the gravel with the silt and clay. If the silt and clay are to be removed, without removing the sand present, a costly flotation process may be necessary.
- 2) Extra cost is incurred in drying the washed aggregates.
- A source of water for washing must be available. In many parts of the Prairie Provinces, an adequate supply of water may not be available at the site.



An increase in the permeability of the gravel may also be accomplished by the addition of trace quantities of portland cement to the gravel before placing and compacting. In the case of the Crawford gravel, the quantity of cement required was found to be 0.45 per cent by weight of dry gravel, as determined by plastic limit tests using varying amounts of cement additive, and from the grain size analysis. The cost of the cement would be approximately 21 cents per cubic yard of gravel treated, i.e. one-fifth of a bag per cubic yard of gravel. The extra handling, mixing and blending cost is estimated to amount to 14 cents per cubic yard of gravel treated. The cost figures used to compute the above are as follows:

- a) Heavy farm tractor and pulvi-mixer, \$5.00 per hour. This would mix 100 cubic yards per hour in two passes, and thus the cost of mixing would be 5 cents per cubic yard of gravel.
- b) Blade grader for extra windrowing and blending required, \$8.00 per hour. This would handle 400 cubic yards per hour and therefore the cost of extra blending would be 2 cents per cubic yard of gravel.
- c) Cost of cement, \$1.05 per sack
- d) Handling required for the cement, 35 cents per sack. This would amount to 7 cents per cubic yard of gravel.

The total cost of adding 0.45 per cent cement to the original gravel would therefore amount to approximately 35 cents per cubic yard of gravel treated.

Unfortunately time did not permit an investigation of the effect of lime and fly-ash upon the permeability of the gravel. As the action of this additive is similar to that of the cement, however, it is thought that anincrease in permeability of the gravel would probably result from

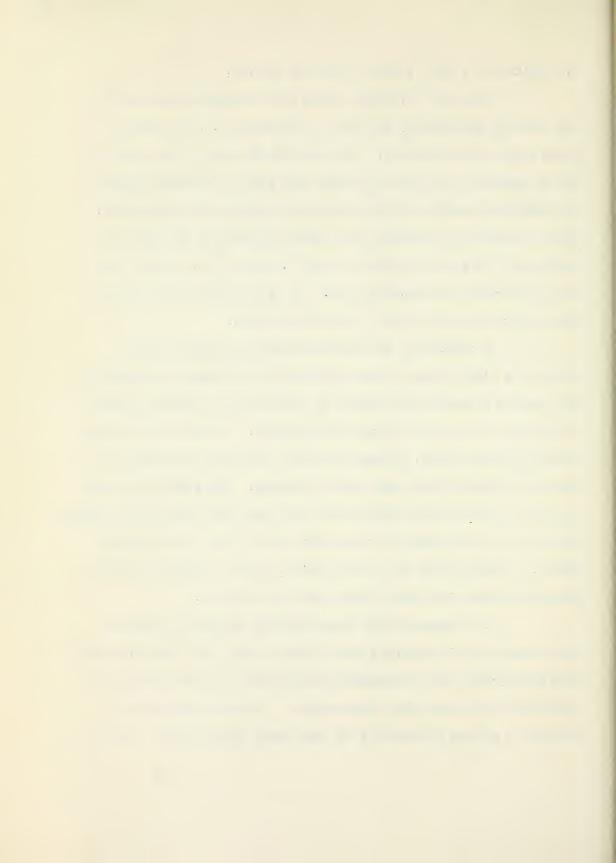
the addition of a small amount of lime and fly-ash.

The cost of handling, mixing and blending the lime and flyash would be approximately the same as for cement, i.e. 14 cents per
cubic yard of gravel treated. In order that the cost of lime and flyash be competitive with that of cement, the amount of lime and fly-ash
is limited to a maximum of 0.2 per cent and 0.4 per cent respectively.

This is based upon a compacted unit weight of gravel of 3500 lbs. per
cubic yard, the cost of quicklime being \$1.00 per 60 lb. sack and the
cost of fly-ash being \$16.00 per ton. It is not known whether or not
these quantities would produce the desired results.

In addition to the increased shearing strength of the gravel at a high moisture content produced by an increase in permeability, the shearing strength could further be increased by an increase in the co-efficient of internal friction of the gravel. Triaxial test results, using the Winger Gravel, indicate a definite increase in the angle of internal friction of the gravel due to crushing. The angle of internal friction of the two-inch crushed gravel was higher than that of the original three-inch screened gravel, but less than that of the 1½-inch crushed gravel. Gravel crushed to one inch showed a small reduction in angle of internal friction from that obtained with the 1½ gravel.

It is suggested that future research attempt to correlate the permeability of compacted plastic fines, treated with cement and with lime and fly-ash, with the permeability of fines of a gravel known to be satisfactory for base course construction. It should be possible to determine a minimum permeability for base course gravel fines. This,



then, could be used as the basis for evaluating a source of base course gravel. Should the permeability of a proposed gravel source be below this minimum, the quantity of cement or of lime and fly-ash needed to increase the permeability could be determined from plastic limit tests and a grain size analysis of the gravel.

In addition, the weathering effects of cycles of freezing and thawing upon the plasticity characteristics of treated gravel fines should be investigated to determine the permanency of the plasticity changes after treating with cement and lime and fly-ash. This was not carried out in the current investigation.

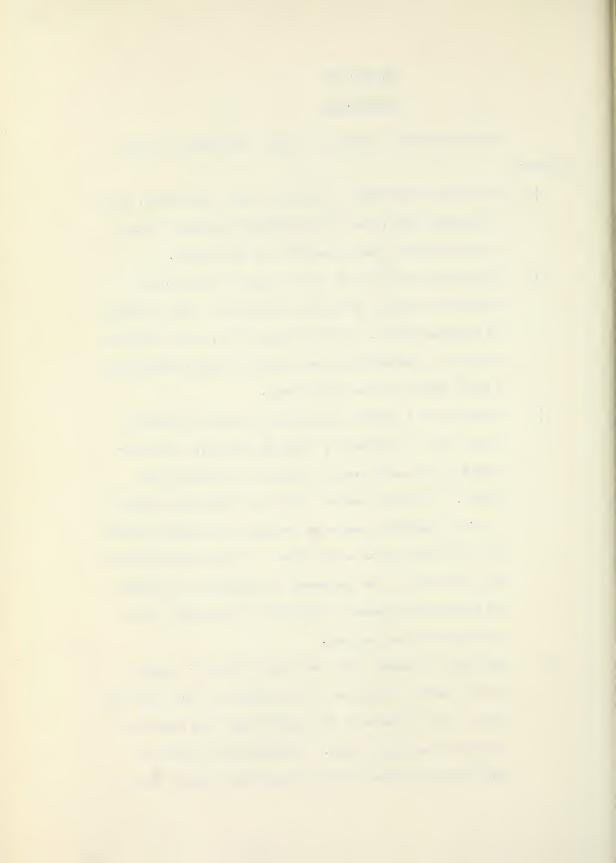


### CHAPTER XII

### CONCLUSIONS

The conclusions arrived at in this investigation are as follows:

- The loss of stability of a gravel, which contains an excess of plastic fines, due to an increase in moisture content results from the low permeability of the gravel.
- 2) The permeability of such a gravel may be increased by screening, washing, or by the addition of a small quantity of portland cement. It is assumed, also, that a similar increase in permeability would result from the addition of a small amount of lime and fly-ash.
- 3) Stability of a gravel, containing an excess of plastic fines, may be increased by crushing the gravel, thus increasing the coefficient of internal friction of the gravel. Crushing, however, does not effectively prevent a loss of stability due to an increase in moisture content for the reason given in (1) above. If the permeability of the gravel were to be increased, in addition to crushing, the potential increase in stability of the gravel due to crushing could be realized.
- is an immediate reduction in the plasticity index resulting from a large increase in the plastic limit and a small decrease in the liquid limit. Thereafter the plasticity index remains constant and the liquid and plastic limits



increased at a constant rate. Above a minimum amount of cement additive, there is no initial increase in the plastic limit with an increase in cement.

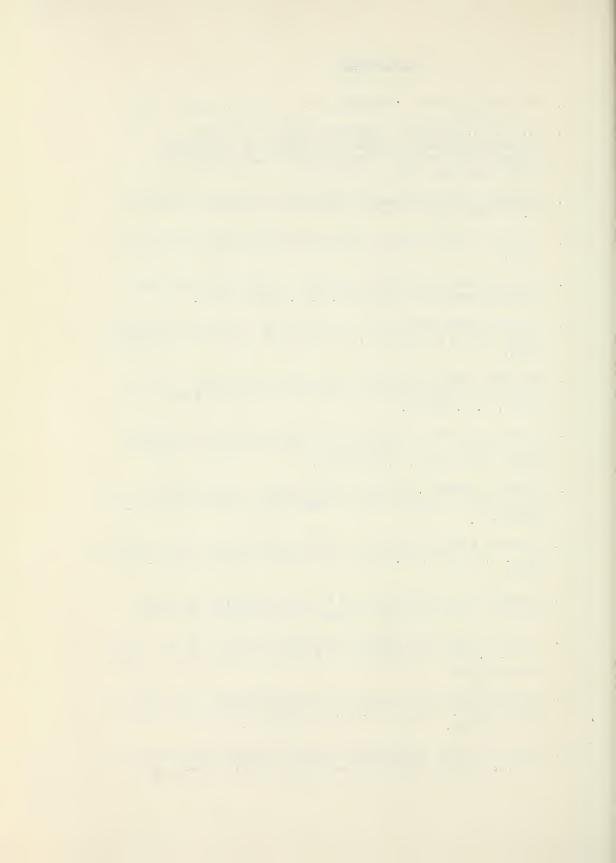
The effect of lime and fly-ash upon the plastic fines of a gravel is an immediate reduction in the plasticity index.

This results from both an increase in the plastic limit and a decrease in the liquid limit. Both the liquid and plastic limits then show an initial reduction with time and then a constant increase as curing takes place.



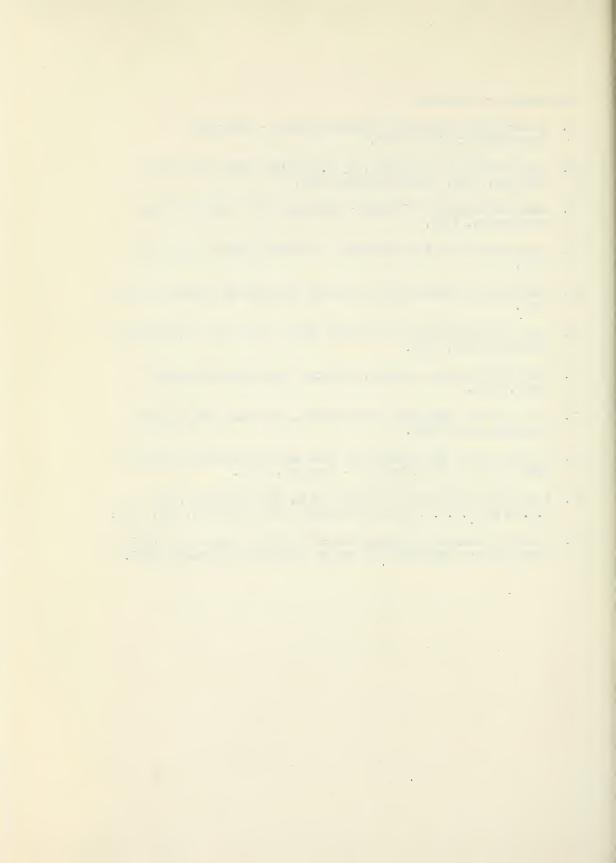
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## APPENDIX A

SAMPLE COMPUTATIONS.



# ESTIMATING THE OPTIMUM MOLDING WATER CONTENTS FOR TRIAXIAL SPECIMENS

For this example, Mixture number 5 is used as it is typical of all cases.

From a compaction test on the minus #4 sieve portion of the gravel, it was found that the optimum moisture content was 11.5%. Mixture number 5 contained 35% minus #4 sieve before crushing, therefore for a total oven dry sample of 100 lbs., the water required for the original minus #4 portion was:

$$.35 \times 11.5 = 4.03$$
 lbs.

The quantity of minus #4 sieve produced by crushing was found from sieve analysis to be 9%. It was assumed that the optimum moisture content for this material was 5%. Thus the additional water required per 100 lbs. of total oven dry aggregate for the crusher fines was:

$$.09 \times 5 = .45 \text{ lbs}.$$

The absortion of the plus #4 sieve material was found from specific gravity tests to be 1.85%. Thus the water required for the remaining 56 lbs. of the 100 lb. sample was:

$$.56 \times 1.85 = 1.04 \text{ lbs}$$
.

Thus the total water required at optimum moisture content was:

# PAVEMENT THICKNESS REQUIREMENTS USING THE KANSAS DESIGN METHODS.

Determining Saturation Coefficient (n).

.. 'n

The 30 year average annual precipitation (1921-1950) for the Carstairs area was 17.5 inches and was obtained from the Edmonton Public Weather Office. From the table of saturation coefficients the value for n was found to be 0.6 (13) (14).

2. Determining the Traffic Co-efficient (m)

The maximum gross load in Alberta is 72,000 lbs. normally be distributed over a 5 axle tractor-trailer combination giving a maximum gross wheel load of 7200 lbs. if the weight were evenly distributed. For this analysis, however, a maximum wheel load of 9000 lbs. (4 axle tractor-trailer combination) was used. This load acts on dual wheels and is consistent with values obtained by the Alberta Highways Department. From the table of Traffic Coefficients, the value for m was found to be 1. (13) (14).

3. Choosing the Thickness Chart.

As a deflection factor, S = 0.1 inch, is common to all Kansas design charts, and as the saturation coefficient (n) was known to equal 0.6, design Fig. A-6 was chosen from reference (14). design chart with m : 1 is illustrated in Figure 17.

4. Choosing the Thickness of Mat Required to cover the Base Course.

For this evaluation Mixture number 5 compacted over optimum moisture content will be used. As a lateral pressure of 20 p.s.i. is not possible with a vacuum triaxial test, the stress strain curve for a lateral pressure of 0.90 Kgm./sq.cm. is used, see Figure 10.

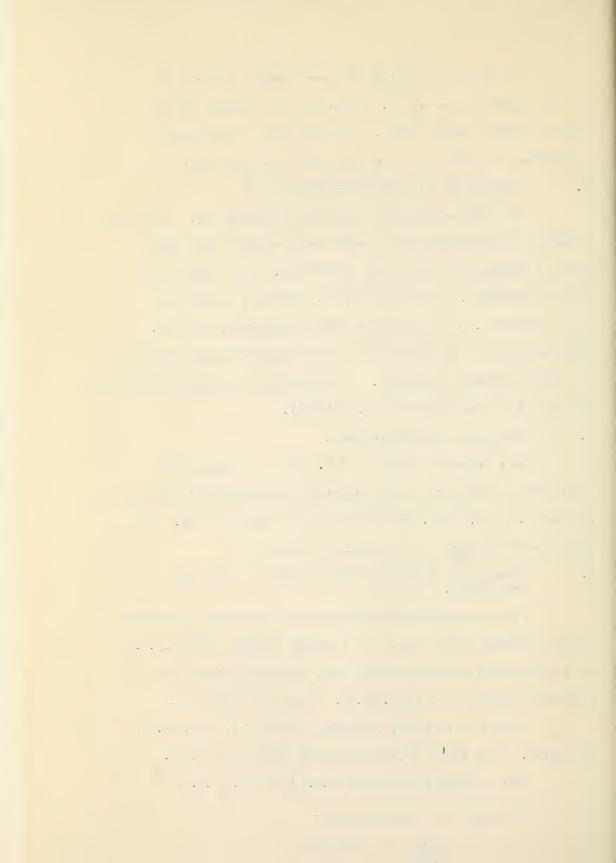
For the first trial, a deviator stress of 1.5 Kgm./sq.cm. From Figure 10, the strain was found to be 1.15%. was chosen.

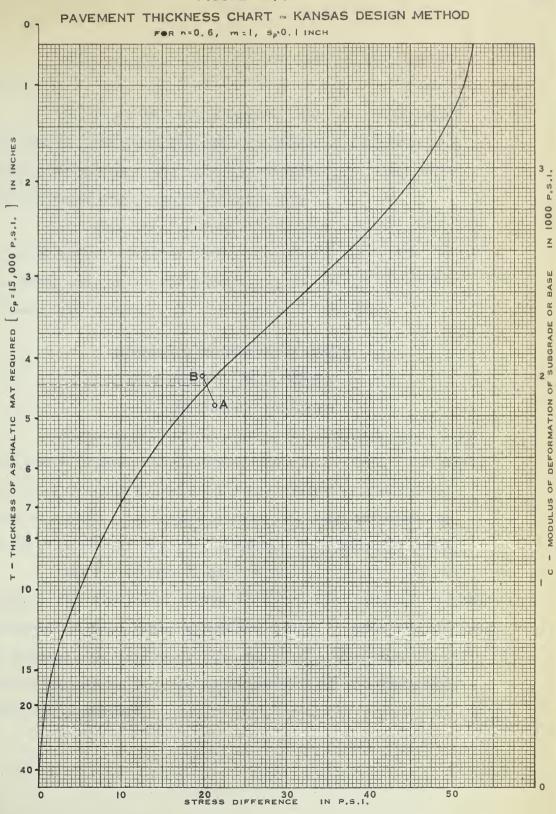
Thus the stress difference (p.s.i.) was 21.4 p.s.i.

The modulus of Deformation was:

21.4 1855 p.s.i.

.0115







These two values were plotted as point A on the thickness chart.

For the second trial, a deviator stress of 1.4 Kgm./sq.cm. was chosen and the stress difference and modulus of deformation were found to be 19.9 p.s.i. and 1995 p.s.i. respectively. These values were plotted as point B on the thickness chart.

A straight line was drawn between these two points which fell on either side of the design curve. The intersection of this line and the design curve was used to determine the thickness of asphaltic pavement cover required. In this case it was 4.4 inches.

# DETERMINING THE QUANTITY OF CEMENT

### TO BE USED IN FORMING TRIAXIAL

### AND COMPACTION TEST SPECIMENS

It was assumed that the quantity of cement to be used in each case should be proportioned according to the surface area of the aggregate using the optimum quantity of cement required by plastic limit tests as a basis. The optimum percentage of cement was found from Figure 15 to be 3 per cent for the Crawford fines (minus #40 sieve).

From the Materials Manual, Testing and Control Procedures,

Volume 1, Test Method Calif. 303-B, January 3, 1956, State of California,

Department of Public Works, surface area factors in square feet per pound

of aggregate were found and plotted, Figure 18. From Figure 18, the

surface area factors to be applied here were found by extrapolation.

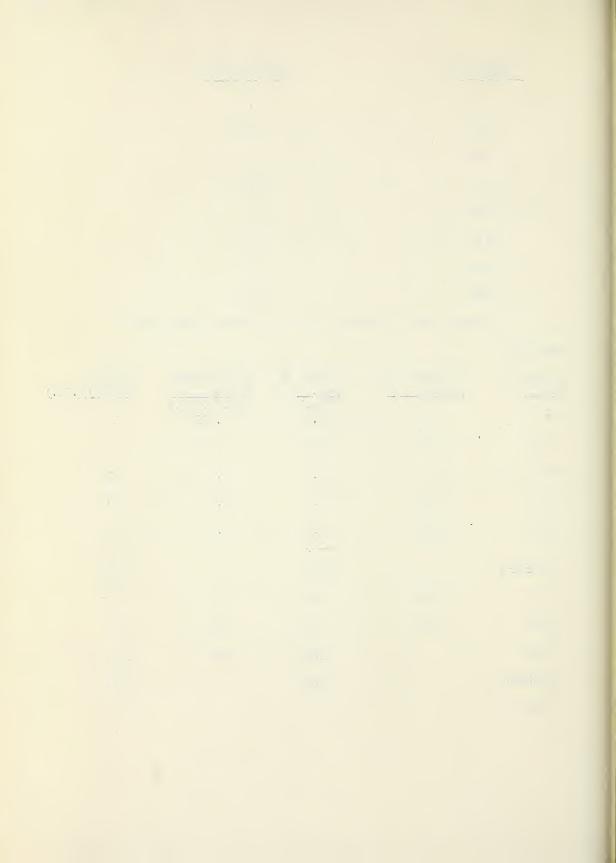
These were as follows:

PASSING SIEVENUMBER	SURFACE AREA in sq. ft./lb.
3"	0.135
1½"	0.26
3/4"	1.0
#4	2.0
#10	4.6
#40	21
#100	58
<b>#200</b>	160

Taking a 100 lb. sample for use in forming the triaxial

## specimen

PASSING SIEVE	RETAINED ON SIEVE	WEIGHT OF AGG. (1bs.)	SURFACE AREA FACTOR (sq.ft./1b.)	SURFACE AREA (sq.ft.)
3"	1½"	10.0	.135	1
12"	3/4"	17.0	.26	9
3/4"	#4	33.0	1.0	33
#4	#10	15.0	2.0	30
#10	#40	11.0	4.6	51
		amidiment-copyage		annual members
Subtotal		86.0		124
#40	<b>#100</b>	1.75	21	37
#100	#200	3.30	58	192
#200		8.95	160	1430
Subtotal		14.00		1659
Total		100.0		1783



The quantity of cement required for the minus #40 sieve portion was

$$\frac{3}{100}$$
 x 14 = 0.42 lbs.

Thus the quantity of cement, based on surface are, required for the plus #40 sieve portion was

$$\frac{124}{1659}$$
 x  $0.42$  = 0.03 lbs.

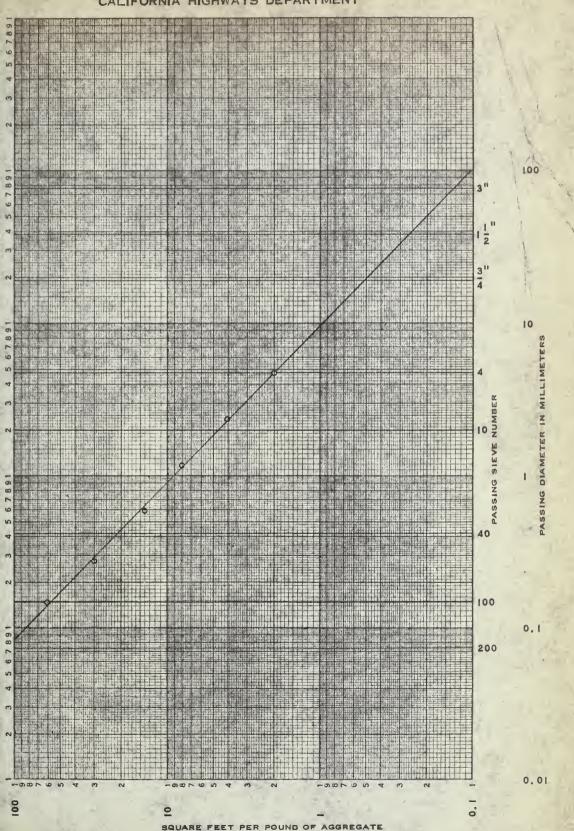
Therefore the quantity of cement required for the triaxial specimen was

$$\frac{0.42 \neq 0.03}{100} = 0.45$$
 per cent by

weight of dry aggregate.

The quantity of cement required for the compaction specimens was found in a similar manner, using #4 sieve material as the top size rather than 3" inch material. In this case it was computed to be 1.1 per cent cement.







APPENDIX B

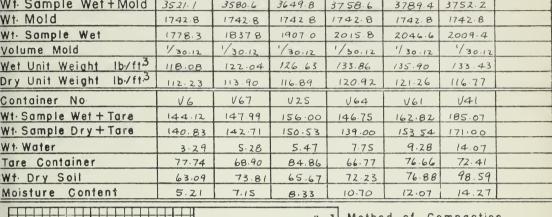
DETAILED TEST DATA FOR PART A

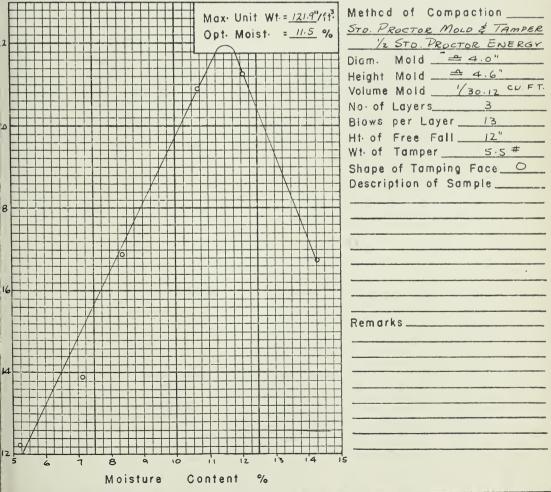


UNIVERSITY of ALBERT	ΓΑ	PROJECT					
DEP'T of CIVIL ENGINEER		NG SAMPLE WINGER - #4 FROM MIXTU					
SOIL MECHANICS LABORATO			NINGER + #4 " " "				
SPECIFIC GRAVIT	Υ	HOLE TECHNICIAN A.C	a. M DATE 9/1/59				
Sample No.		/					
Flask No.		15	`				
Aethod of Air Removal		VACUUM.					
VD+w+s		919.60					
lemperature T		20.05°C					
N <sub>b+w</sub>		640.07					
Evaporating Dish No.		-					
Wt. Sample Dry + Dish		1378.25					
Tare Dish		932.60					
Ws		445.65					
Gs		2.68					
Wb+w+s = Weight of flask + wa	iter +	sample at T°.					
W <sub>b+w</sub> = Weight of flask + wa	ter at	T° (flask calibrati	on curve).				
W <sub>S</sub> = Weight of dry soil G <sub>s</sub> = Specific gravity of	soil no	rticles = Ws	14/				
G <sub>s</sub> = Specific gravity of s	3017 PC	W <sub>s</sub> + W <sub>b+w</sub> -	-Wb+w+s				
Determination of W <sub>S</sub> from wet	soil	sample:					
Sample No.		Sample No.					
Container No.		Container No.					
Wt. Sample Wet + Tare		Wt. Test Sample Wet+	Tera				
Wt. Sample Dry + Tare		Tare Container					
Wt. Water		Wt. Test Sample Wa	1				
Tare Container		W <sub>S</sub>					
Wt of Dry Soil							
Moisture Content w %							
Description of Sample: Winger + *	4.		,				
WEIGHT SAMPLE (SS.D) +TARE	5328	00 Gs BULK	c = B-c = 2.58				
WEIGHT TARE	1225.	95 Gs BUL	K(5.5.0) = B.c = 2.63				
(B) WEIGHT SAMPLE (S.S.D)	4102	05 GS APPAI	ZENT = A-c = 271 *				
			D 0				
Remarks: WT. SAMPLE(S.S.D) + BASKET IN W.	ATER 324	4.0 ABSORP	TION % = B-A x 100 = 1.79				
WT. BASKET IN WATER		2.2					
(C) WT. SAMPLE (S.S.D) IN WAT	ER 25	11.8					
	*		AUERAGE GS FOR				
(A) WT. SAMPLE (OVEN DRY)	407		BINED COARSE & FINE				
		AGG	REGATES = 2.70				



PROJECT UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE WINGER - # 4 FROM MIXTURE # 1 SOIL MECHANICS LABORATORY LOCATION (ALSO USED FOR MIXTURES 4,5,6) DEPTH COMPACTION TEST HOLE TECHNICIAN K.a. M. DATE 29/12/58 Il Number 6 Mold No. 1 1 1 Wt. Sample Wet + Mold 3521.1 3580.6 3649.8 3752.Z 3758.6 3789.4 1742.8 1742.8 1742.8 1742.8 1742.8 1742.8 1907 0 2015.8 2009.4 1778.3 1837.8 2046.6 1/30.12 1/30.12 1/30.12 1/30.12 1/30.12 1/30.12 1b/ft3 133.43 118.08 122.04 126 63 133.86 135.90 1b./ft.3 120.92 116.77 112.23 113.90 116.89 121.26 V67 V25 1141 V6 V64 V61 147.99 144.12 156.00 146.75 162.82 185.07



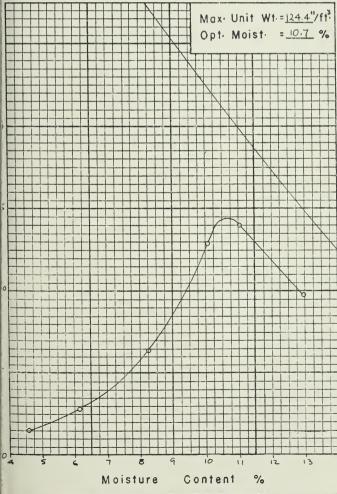




UNIVERSITY OF ALBERTA
DEP'T OF CIVIL ENGINEERING
SOIL MECHANICS LABORATORY
COMPACTION TEST

PROJECT	
SITE	
SAMPLE WINGER - #4	FROM MIXTURE #2
LOCATION	
HOLE	DEPTH
TECHNICIAN B. a. M.	DATE 29/12/5

	. =	-	TECHN	ICIAN K	u m	DATE :	29/12/58
Number	/	2	3	4	5	6	
10ld No.	/	/	/	/	/	/	
Vt. Sample Wet+Mold	3499.1	3546.4	3640.9	3780.1	3816.0	3779.8	
Vt. Mold	1742.8	1742.B	1742.8	1742.8	1742.8	1742.8	
Vt. Sample Wet	1756.3	1803.6	1898.1	2037.3	2073.2	2037.0	
'olume Mold	1/30.12	1/30.12	1/30:12	1/30.12	1/30.12	1/30.12	
let Unit Weight 1b/ft3	116.62	119.77	126.04	135.28	137.67	135.26	
ry Unit Weight lb/ft.3	111.46	112.79	116.43	122.88	123.99	119.74	
ontainer No	V65	V 63	V 23	U62	U68	V 24	
/t· Sample Wet + Tare	115.71	136.09	129.44	119.05	166.92	166.78	
Vt. Sample Dry + Tare	113.59	132.11	124.86	114.10	158.99	156.58	
Vt- Water	2.12	3.98	4.58	4.95	-7.93	10.20	
are Container	67.85	67.77	69.34	65.02	87.12	77.88	
Vt. Dry Soil	45.74	64.34	55.52	49.08	71.87	78.70	
Acisture Content	4.63	6.19	8.25	10.09	11.03	1 12.96	



Method of Compaction

Sto. Proctor Mold TAMPER

1/2 Sto. Proctor Energy

Diam. Mold 4.0"

Height Mold 4.6"

Volume Mold /30.12 CV.FT.

No. of Layers 3

Blows per Layer 13

Ht. of Free Fall 12"

Wt. of Tamper 5.5 LBS.

Shape of Tamping Face O

Description of Sample



PROJECT UNIVERSITY of ALBERTA SITE DEP'T. of CIVIL ENGINEERING SAMPLE WINGER - # 4 FROM SOIL MECHANICS LABORATORY LOCATION MIXTURE #3. COMPACTION TEST HOLE DATE 8/1/59 TECHNICIAN al Number 4 5 6 Mold No. Wt. Sample Wet + Mold 34615 3549.9 3677.0 3831.7 3789.2 Wt. Mold 1742.8 1742.8 1742.8 17 42.8 1742.8 Wt. Sample Wet 1718.7 1807.1 1934.2 2088.9 2046.4 Volume Mold 1/30.12 1/30.12 1/30.12 1/30.12 1/30.12 Wet Unit Weight Ib√ft<sup>3</sup> 114.13 120.00 128,44 138.71 135,89 Dry Unit Weight 1b./ft.5 110,16 113.42 118.16 120.58 125.42 Container No-V.37 V 7/ A 15 V46 v 42 Wt. Sample Wet + Tare 132.81 148.71 115.28 146.35 162.26 Wt. Sample Dry + Tare 130.49 144.48 111.39 151.58 14037 Wt. Water 2.32 3.89 5.98 10.68 4.23 Tare Container 66.62 72.04 66.64 83.69 62.38 Wt. Dry Soil 56.68 84.20 63.87 72.44 44.75 Moisture Content 3.6 5.8 8.7 10.6 12.7 Method of Compaction Max. Unit Wt = 125.7 "/ft" STD. PROCTOR MOLD & TAMPER Opt. Moist. = 10.7 % 1/2 STD. PROCTOR ENERGY Diam. Mold = 4.0" Height Mold \_ 4.6" Volume Mold /30.12 CU.FT. No. of Layers\_\_\_\_\_3 Blows per Layer 13 130 Ht. of Free Fall 12" Wt. of Tamper S.5 LBS Shape of Tamping Face O Description of Sample \_\_ 125 Remarks\_ 115

Content

Moisture

%



	ι	JN	IV	EF	25	317	ΓY	1	O	f		ALI	BE	R'	ΓΑ			PROJE	C	T					
UNIVERSITY of ALBERTA DEP'T of CIVIL ENGINEERING															SITE										
												SAMPLE WINGER MINUS # 40													
SOIL MECHANICS LABORATORY												LOCATION													
ATTERBERG LIMITS											S	TECHNICIAN B. C. M. DATE 17/12/58													
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_	am											39	1		.66	-		09.03	-	97.35		95.			05.10
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13	1 41	-			-	-	-	73	T	77	21	. D	1		1.0			22.6		22.5		20	6		20.3
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				-				1		$\coprod$	$\pm$	1					Tri	al No				/	2		3
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2			-				-	+	4	$\forall$	H	++++	+		+++++		Shr	inkage	V	101. V-Vo	L				
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							1			Ħ	X		#			Ш					, ,	,			,
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-	7 8	3 9	)			h		5	0.4		20	25	3	0	40	ן									
				DI I	I II	. (1	- F						-			- 61									



					ALBE	SITE								
	DEP	Γ· of	CIVIL	_ EN	GINE	ERING	SAMPLE WINGER PIT - MIXTURE #1							
	SOIL	MECH	ANICS	L	ABORA	TORY	LOCATION MIXTURE #1							
						SION	11015							
	11/17	ANIAL	_ 0	OIVIE	UC2	21011	TECHNICIAN 15 a. M. DATE 7/1/59							
1ac	hine D	ata:-						Dec	crint	ion of C	`anala	DAIL	// 37	
lac	hine No	0		T.0				NA	77///	1011 01 3	ample	EENED TO	3" 10 -	
	iplicat													
/t. L	.oading	Block	+ Pis	ton la	me)	21 16			mp	CIED	HT D	PT. Mois	TURE.	
				1011 (9	1113.7	21107	777.							
					SPEC	IMEN			DAT	ΓΑ				
Spe	cimen	Numbe	er				1		2	3	4	5	6	
Lat	eral F	ressu	re	(07%)	Kaml	59. cm.	0.30				<u> </u>		-	
Len	igth			inches	7	7	245/	2						
Are	a			sq. cms			730							
101	ume				cu. t	c+.	1.612							
	Unit W	eight					132.7							
3 <sub>S</sub> =					s Yw.	-4					,			
7	Tare +						139.6	-		WET SOIL	USED	225	165.	
N+.	Tare +	Soil	Wat	er a										
			17016	er di	end		5210							
	Tare +						4964							
	nber ar	id wei	ght o	Tare	-		214							
N S.	Soil						4750							
3ef	ore			water										
Te		Moist	ure c	onten	t									
		Degre	e of	satur	ation									
Aft	er	Weigh	t of	water			246							
Te		Moist	ire c	onten	t		5.18					-		
	31			satur		%	52							
a d				T										
n	Dial Rdg	Strain	Area	01-	Load	Diai		Area	01	Load	Dial	Strain Ar	0.0	
ın	Rug	-		Tin	Pan	Rdg.				Pan	Rdg-	Sir dill Al	ea or	
-		10/	- 3	1/ />	V,		-							
7	105.	%	Cm-	Kamlom	Kamlon		-		-	_				
	0.926	-	730	.03			-		-			-		
2	0.918		730	.17	·33 ·47		-							
2	0.911	.06	730	.30	.60		1		-			-		
0	0.895	.13	731	.44	.74							<del>                                     </del>		
2	0.876	.20	731	.58	-88								-	
2_	0.859		732	.71	1.01									
2	0.843		732	185	1.15				-					
	0.827		733	.98	1.28		-							
	0.792		<u>733</u> 734	1.12	1.42					-				
0	0.772	.63	734	1.39	1.56		-		-		-			
	0.745		735	1.53	1.83									
20	0.717	.85	736	1.66	1.96									
	0.672	,	737	1.79	2.09						-			
	0.585	1.39	740	1.92	2.22									
20	0.400	3.14	746	1.96	2.26					. [ ]				
				i	-			77						
						PAIL	RE B	Y 04	LGII	Vie.				
	The state of the s													
	-													



	UNIVE DEP TO SOIL TRI-A	of C MECHA	NICS	ENG	BORAT	RING ORY		PROJECT SITE SAMPLE WINGER PIT MIXTURE #1 LOCATION HOLE TECHNICIAN K.A. L. DATE 7/1/59						
achi	ine Da	ta:-						Desc	ripti	on of	Sample:			
chi	ne No olicatio			T.0				NATIV	E G.	RAVEL	SCREEK	VED TO		
								Com	PAC	TEO ,	YT OF	T. MOIST	IRE.	
. Lo	ading	Block -	+ Pist	on (gm	s.)	21 K	gm.							
					SPECII	MEN		1	DAT	A				
pec	imen 1	lumber	<del></del>				1	2		3	4	5	6	
	ral P			97K )	Kamls	S. Con	0.60							
	t h			nches		^	241							
red							730							
	m e_		2	C- 57	cu. ft		1.60	7						
ry	Unit W	eight	I	bs/cu-f	t. 8d		133.	4						
s=		lume				et	140.	3.		WET So.	USED	225	165.	
Vt. 7	are +	Soil +	Wate	r at	start									
	are +						447						-	
	are +						426	9						
	ber an	d weig	tht of	Tare			22	0			-			
Vt.	Soil						404	9			ļ	-	-	
efo	re	Weigh												
Tes	1	Moist												
		Degra			ation									
Aft	er -	Weight					209						-	
Tes	it -			ontent		-/	5.14				-		-	
		Degre	e of	satura	ition	%	53							
o d	Dial	Strain	Area	01-	Loge	Dial	Strai	Area		Logo	Dial	Strain A	real or	
n	Rdg	311 0111	Aleu	7111	Pan	Rdg	. 01141	Area		Pan	Rdg	Sil dill A	, ed	
					4,									
2	ins	0/0	Cm	Kamlon	Kam/cm							-		
	0.929	-	730	-03	.63		-	+			1		-	
0	0.918	.04	730	.30	.90									
0	0.895		731	.58	1.18			-		_				
2	0.875	-	731	1.12	1.72			-	-					
0	0.834				1.99		-	-				+		
20	0.811	.48	733	1.67	2.27									
20	0.779	.61	734	1.94	2.54						-			
20	0.742	.76	735	2,21	2.81		-	-						
010	0.635	1.20	737	2.47	3.07		-	-	-		-	-		
20	0.568	1.47	741	2.73	3.33									
0	0.480		743	2.85	3.45									
20	0.120	3.30	755	2.94	3.54									
1		1							-					
					FAI	LURE	M BUL	GXNG.						
		-					-							
1		-									-	-		
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	LINIDAG	DOLLA	1 -	£ 1	DEC	TA		PROJE	CT					
	UNIVE							SITE						
	DEP T.	of C	IVIL	ENG	INEE	RING			EH	VIN	GER	Pir -	MIXTU	RE #1
	SOIL	MECHA	NICS	LA	BORAT	ORY		LOCAT						
												,	DEPTH	
	TRI-A	NAL	00	אאוע	1522	NOI		TECHN	ICIA	N	15.a.	W.	DEPTH DATE 7	11/59.
ach	ine Da	t a:-		,										
a c h	ine No-	1 4 .		T.O.				NATU	IE I	60	AVE	SCREE	NEO TO	3" MAX
	olicatio												MOIST	
						2. 1.		Com	PAC	/ C	U A	1 021	. "10151	UKE.
· Lo	ading	Block -	+ Pist	on (gm	15./	1/29.	m.							
					SPECII	MEN		1	DAT	A				
nec	imen N	Jumber					ı	2	T		3	4	5	6
pec	illien i	101111111111	- /:	- 1 2	/ /-								1-3-	0
are	ral P	ressur	e ((	17 1 X	gm/59	, Cm.	0.90	,					+	
en c	11h		11	nches			243/	В						-
re			S	q. cms.			730						-	
	m e		c	C-8-	cu.f	7.	1.595							
	Unit We	eight	1	bs/cu-f	t. 8d		135.3							
is=	· Vo	lume	Soil	Solids	8 W.	-+	142.			WE	T 501L	USEO	227	165.
	Tare +													
	are +						467.	3						
			11-01-0		0110		447.							-
	Tare +		. h. h f	To						-			-	
	ber an	a werd	int of	lare			6/8							
V † .	Soil						385	7					-	
efo	re	Weigh												
Tes		Moistu	re c	onten	t									
168		Degre	e of	saturo	ation									
Aft		Weight					201							
	٠,	Moistu			1		5.22							
Tes	st	Degre		***************************************		%	58						<b>†</b>	
		Jegre	<del> </del>	o d i d i c		10	30			<u></u>				
ad					11 4		1				Local		1 1	
	Dial	Strain	Arec	-	Load	Dial	Strain	Area	6		Load	Dial	Strain A	ren T
וח ח	Dial Rdg	Strain	Area		0.0	Dial Rdg		Area	01		on Pan	Dial Rdg	Strain A	rea or
n		Strain		VIII.	Au Su			Area	0,		on		Strain A	rea or
n		Strain %		VIII.	Pan			Area	0.		on		Strain A	rea 67
חוח	Rdg	0/0	Cm²	VIII. Kamlen	on Pan Vi Kam/cm			Area	6.		on		Strain A	rea $\sigma_{\tau}$
n in	/23. 0.945	0/0	Cm <sup>2</sup>	Kamlen 103	Pan Vi Kam/cm	Rdg		Area	5.		on		Strain A	rea or
n in F	0.945 0.935	0/0	730 730	VIII Kamleñ 103 130	93 1.20	Rdg		Area	σ,		on		Strain A	rea or
7 70 70	0.945 0.935 0.918	- 04	730 730 730	VIII Kamlch .03 .30	993 1.20	Rdg		Area	5.		on		Strain A	rea 57
7 20 20 20 20	0.945 0.935 0.918 0.895	-04 -11 -21	730 730 730 730 731	VIII. Kamlen .03 .30 .58	93 1.20 1.48	Rdg		Area	σ.		on		Strain A	rea ST
n in 7 70 70 70	0.945 0.935 0.918 0.895 0.875	-04 -11 -21 -29	730 730 730 730 731 732	Kamlen .03 .30 .58 .85 1.12	93 1.20 1.48 2.02	Rdg		Area	σ.		on		Strain A	rea ST
70 70 70 70 70 70 70 70 70 70 70 70 70 7	0.945 0.935 0.935 0.918 0.895 0.875		730 730 730 730 731 732 732	Xqm/cm .03 .30 .58 .85 1.12 1.39	93 1.20 1.48 1.75 2.02	Rdg		Area	51		on		Strain A	rea &T
n in 20 20 20 20 20 20	Rdg  0.945  0.935  0.918  0.895  0.875  0.829		730 730 730 730 731 732 732 733	Xqm/cm .03 .30 .58 .85 1.12 1.39	93 1.20 1.48 1.75 2.02 2.29 2.57	Rdg		Area	σ.		on		Strain A	rea &
n in 20 20 20 20 00 00	0.945 0.935 0.935 0.918 0.895 0.875 0.851 0.829 0.804	-04 -11 -21 -29 -39 -48 -58	730 730 730 731 732 732 732 733 734	Xuu Kqmlen .03 .30 .58 .85 1.12 1.39 1.67	93 1.20 1.48 1.75 2.02 2.29 2.57 2.84	Rdg		Area	5.		on		Strain A	rea or
n in 20 20 20 20 20 20 20 20 20 20	0.945 0.935 0.918 0.895 0.875 0.851 0.829 0.804 0.777	-04 -1/ -2/ -39 -48 -58	730 730 730 730 731 732 732 733 734 735	Nul. Kqmlen .03 .30 .58 .85 1.12 1.39 1.67 1.94 2.21	93 1.20 1.48 1.75 2.02 2.29 2.57 2.84	Rdg		Area	σ.		on		Strain A	rea or
n in 20 20 20 20 00 00	0.945 0.935 0.935 0.918 0.895 0.875 0.851 0.829 0.804	-04 -1/ -2/ -39 -48 -58	730 730 730 731 732 732 733 734 735 736	Niii Kqm/ca · 03 · 30 · 58 · 85 · 1.12 · 1.39 · 1.67 · 1.94 2.21 2.48	993 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38	Rdg		Area	σ.		on		Strain A	rea or
n in 77 10 20 20 20 20 20 20 20 20 20 20 20 20 20	0.945 0.935 0.918 0.895 0.875 0.851 0.829 0.804 0.777 0.744		730 730 730 730 731 732 732 733 734 735	Nul. Kqmlen .03 .30 .58 .85 1.12 1.39 1.67 1.94 2.21	93 1.20 1.48 1.75 2.02 2.29 2.57 2.84	Rdg		Area	67		on		Strain A	rea or
n in 70 70 70 70 70 70 70 70 70 70 70 70 70	0.945 0.935 0.918 0.895 0.875 0.851 0.829 0.804 0.777 0.744 0.703	-04 -1/ -2/ -39 -48 -58 -69	730 730 730 731 732 732 733 734 735 736	Niii Kqm/ca · 03 · 30 · 58 · 85 · 1.12 · 1.39 · 1.67 · 1.94 2.21 2.48 2.74	993 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64	Rdg		Area	67		on		Strain A	rea or
n in 70 70 70 70 70 70 70 70 70 70 70 70 70	0.945 0.935 0.948 0.895 0.875 0.851 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.491		730 730 730 730 731 732 732 733 734 735 736 737	Niii Kqm/ca · 03 · 30 · 58 · 85 · 1.12 · 1.39 · 1.67 · 1.94 2.21 2.48 2.74 3.01	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29	Rdg		Area	67		on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -125 -1-57 -1-84 -2-/3	730 730 730 731 732 732 733 734 735 736 737 739 741 743 746	VIII Kgm/ca ·03 ·30 ·58 ·85 I.12 I.39 I.67 I.94 I.21 III III III III III III III I	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42	Rdg		Area	67		on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -125 -157 -184 -2-/3 -2-64	730 730 730 731 732 732 733 734 735 736 737 739 741 743 746	VIII Kgm/ca ·03 ·30 ·58 ·85 I·12 I·39 I·67 I·47 I·	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53	Rdg		Area	67		on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425 0.302	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -1.25 -7.57 -7.84 -2.73 -2.64 -3.74	730 730 730 731 732 733 734 735 736 737 739 741 743 746 749	VIII  Kgm/ca  ·03  ·30  ·58  ·85  I·12  I·39  I·67  2·48  2·74  3·21  3·39  3·52  3·63  3·69	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53 4.59	Rdg		n Area	67		on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -125 -157 -184 -2-/3 -2-64	730 730 730 731 732 732 733 734 735 736 737 739 741 743 746	VIII  Kgm/ca  ·03  ·30  ·58  ·85  I·12  I·39  I·67  2·48  2·74  3·21  3·39  3·52  3·63  3·69	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53	Rdg		n Area	67		on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425 0.302	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -1.25 -7.57 -7.84 -2.73 -2.64 -3.74	730 730 730 731 732 733 734 735 736 737 739 741 743 746 749	VIII  Kgm/ca  ·03  ·30  ·58  ·85  I·12  I·39  I·67  2·48  2·74  3·21  3·39  3·52  3·63  3·69	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53 4.59	Rdg					on		Strain A	red or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425 0.302	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -1.25 -7.57 -7.84 -2.73 -2.64 -3.74	730 730 730 731 732 733 734 735 736 737 739 741 743 746 749	VIII  Kgm/ca  ·03  ·30  ·58  ·85  I·12  I·39  I·67  2·48  2·74  3·21  3·39  3·52  3·63  3·69	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53 4.59	Rdg		BULGIN			on		Strain A	rea or
n in	0.945 0.935 0.935 0.895 0.875 0.829 0.804 0.777 0.744 0.703 0.640 0.562 0.497 0.425 0.302	-/6 -04 -1/ -2/ -29 -39 -48 -58 -69 -83 -99 -1.25 -7.57 -7.84 -2.73 -2.64 -3.74	730 730 730 731 732 733 734 735 736 737 739 741 743 746 749	VIII  Kgm/ca  ·03  ·30  ·58  ·85  I·12  I·39  I·67  2·48  2·74  3·21  3·39  3·52  3·63  3·69	99 1.20 1.48 1.75 2.02 2.29 2.57 2.84 3.11 3.38 3.64 3.91 4.17 4.29 4.42 4.53 4.59	Rdg					on		Strain A	rea or



	UNIVE	RSITY	V 0	f Al	BED	TA			OJE	CT					,		
								SIT	E		,						
	DEP T											GER	PIT -	MIXTL	IRE	*	1.
	SOIL								CAT					DEDTU			
	TRI-A	XIAL	CC	MPF	RESS	ION		TE	LE	ICLA	N	Ba	M	DEPTH	22/	11/	59
ach	ine Da	t a:-						1								, /	31
achi	ne No	10:-		7.0				NA	TIME	PI	-P	OT 5	ample:_ Screen	ED TO	3"	M	gx.
	ne No. olicatio												APPROX				
	ading					21 Kar	n.						CIRC. G				
1. 20	ading							1					~				
					SPECII	MEN				AT	A						
Spec	imen M	lumbei	•		, ,			-	2			3	4	5	-		6
_ate	ral P	ressur	e (c	17% ) /	cam/s	g.cm.	0.30	_						-			
_eng	In			iches			243/	4			-						
Arec	3		S	q. cms.		,	720	-						-			
	m e	iaht	<u></u>	he /cu &	CW. FT	-	1.600	-						-	-		
	Unit We					,	133.				1/		11-	-		11	
	· Vc					et.	141.0	1.			WE	T JOIL	USEO	22	/	165	
	are +						426	3			-			-			
	are +		MUIEI	uı	enu		401							-			
	ber an		tht of	Tare			<u>401</u> 215							-			
	Soil	u well	401 01	rure			380				-						
		Weigh	t of w	vater			300.	~			-			-			
3efo		Moist			}						-			-		_	
Tes	it -	Degre												-			
A.F.I		Weight					240	6			-						
Aft	- 1	Moistu					6.4							-		_	
Tes	it -	Degre				%	67										
ad							T					Lond				==	
ad	Dial' Rdg	Strain	Area	07	Load	Dial Rdg	Strain	ri A	rec	0.		Load	Dial Rda	Strain	Ar	ea	51
חנ	Rug				Pan	Kug.		+-				Pan	ray.			-	
AD	DIAL	CIRC	STRAIN	DC	AREA	T T.	1 4	+								+	
	ROG	ROG				711											
		-				-,,-		7									
lm.	ins.	175	%	115.	Cm <sup>2</sup>	Kamlon	Kgm/c	m			-						
2	2.957	39'3/16	-	-	720	.03	.33	3			-					+	
20	2.948	11	.02	-	720	.17	.47	-									
00	2.940	,,	.05	-	720	.31	.6	_									
20	2.924	70.7/	-//	-	720	.45	.7:			Low November							
00	2.895	397/8	.23	1/16	723	·58	1.0										
20	2.809		·38 ·58	116	723	.86	1.16									-	
20	2.748	39 15/16	·82	1/8	725	199	1.20										
20	2.670	40 1/16	1.14	1/4	730	1.12	1.4.	1						-			
20	2.580	40 1/8		5/16	732	1.26									1	_	
00	2.315	40 /2		11/16	738	1.38		7									
100	1.000	40 1/8	Commence of the last	1 1/16	762	1.60											
00	0.560	411/2	9.67	1"/16	787	1168								-			Carrie annual contract and the same
80	0.140	421/8	11.36	25/16	812	1.73	2.0	3								_	
-							FAI	LUR	E	BV	BA	KGING					-
-		+	1			1	- 77	- 1/2		-/-			1	1			Person makes or a manual



	JNIVE DEP TO SOIL TRI-A	of C MECHA XIAL	NICS	ENG LA	INEE BORAT	RING		LOCAT HOLE TECHN	E W	N.	ĸ.a	P.+ -	DEPTH DATE /			
lach	ne Da	t a :-						Desci	ripti	on	of S	ample:				
	ne No											SCREEN				
	licatio											APPRO				
t. Lo	ading	Block -	+ Pisto	on (gm	s.)	21 Kg0	7.	FELT	LIN.	ER	£ (	CIRC G	AUGE	15	ξD.	
-					SPECII	MEN		[	TAC	A						
Spec	imen N	lumber	,				1	2	T		3	4	5			6
	rol P			7% ) K	am / 5a	.cm.	0.60									
Leng			ir	ches	/	- Control	245/8									
Are				q. cms.			720						· · · · · · · · · · · · · · · · · · ·			
Volu					cu.f.	4.	1.591									
	Unit We						133.3									
	· Vo					+	142.0			WE	T 5011	USED	22	6	165.	
	are +						.,,~			7 2	1 0012	0300	1			
	are +						496	/					1			
	are +						4702									
	ber an		tht of	Tare			691						1			
	Soil	<u></u>					4011									
		Weigh	t of w	ater										_		
Befo	1	Moistu			<del></del>								1	1		
Tes		Degre				1		1					1	_		
461		Weight					259		1							
Aft	1	Moistu					6.46							_		
Tes	1	Degre				%	67						1	_		
200											Load		1			
oad on	Dial	Strain	Area	01	Load	Dial Rdg	Strain	Area	5.		0.0	Dial Rda	Strain	Are	e a	51
an	Rdg	-			Pan	ray.	-				Pan	Kag.				
DAD	DIAL	CIRC	STRAIN	7	APFA	VV.	4								+	
27.0	ROG	ROG	OT A PIN		170077	V. V.										
9n.	105.	173.	%	105.	cm2	Kgm/cm2	Kam/cm			_					-	
-		- 7/	-				/ / 2								+	
200	2.837	39 7/8 39 7/8	-		720	.03	1 .63						-		+	
-00	2.800		.21	-	-11	. 58									Ì	
200	2.750		.41	-	"	.86	1.46					1				
300	2.682		.69		1	1.14				_						
200	2,590		1.06	1/8	725	1.41	2.11	-							-	
<del>200</del>	2.465	401/16	2.23	3/16	728	1.68	2.54	-			-		<del> </del>		-	
500	1.950			1/2	740	2.19		and the same of the same of							1	-
300	1.455		5.67	3/4	750	2.43		1								
900	0.950		7.72	1 1/4	769	2.50		7		_			-		-	
100	- 0.030		·	13/4	789	2.56							-			
100	- 0.030	421/8	11.70	2 1/4	810	4.62	3.2	1	}		-				-	m e A erandenger - 1010an ( 6
						FAILUR	CE BY	BULGII	VG.							
															_	
-		1			1	1	1	1	1			1	1		-	
		<del> </del>			ļ	ļ							1			
		-														



1	UNIVE DEP TO SOIL TRI-A	of C MECHA	NICS	ENG LA	INEE BORAT	RING		LOCAT	E W	-	P17 -	DEPTH		
chi	ine Dat	ta:-						Desc	riptio	on of	Sample:			
	ne No-										SCREENE			
	olicatio					2. 1/					APPRO			
, Lo	ading	Block -	+ Pist	on (gm	IS.)	21 Kg.	m .	FEL7		JER Z	CIRC	GAUGE	5 0	SED.
					SPECII	MEN			DATA	<u> </u>				
	imen N						1	2		3	4	5		6
ate	ral Pi	ressur	e (c	172 ) /	Kgm. 13	9. cm.	0.90							
eng	<u>th</u>		ir	nches			245	8						
rec				q. cms.			720				-	-		
	m e	i a b A		- G- 9-			1.591							
	Unit We	lume				1	137.4			1.1 6	1/		33 /	/
S=						T	146.	5	- 1	NET DOIL	USED	1 2	33 /4	>5.
	are +						4513	,			-			
	are +		Wulc	u u	enu		427				1			
	ber an		tht of	Tara			618				<b>+</b>	-		
	Soil	4010	4111 01	1010			3659					1		
		Weigh	t of v	vater			000)				İ		_	
efo	16,	Moistu			<u> </u>								_	
Tes	τ –	Degre												
fte		Weight					236							
Tes	٠, ٢	Moistu					6.4	5						
163		Degre	e of	satura	ition	%	78							
1d	Dial				Load	Digl		T		ILogo	Dial			
ח	Rdg	Strain	Area	01	on Pan	Rdg.	Strain	n Area	5.	Pan	Rdg	Strain	Are	0 01
90	DIAL		STRAIN	DC	AREA	$\nabla_{i} - \nabla_{ii}$	V,							
	ROG	ROG					-	+				-		
77	ins.	ins.	%	ins.	cm2	Kamlom	Kamlen	2	-					1
						7 11	7							
	2.862		- (5)	-	720	•03	. 93				-			
0	2.759	"	·13	-	11	·31	1.4					-		
10	2.668	11	.79	_	- 11	.86	1.7							
00	2.573	39 15/16	1	1/16	723	1.14	2.0							
20	2.470			3/16	728	1.40	2.3				-	-		-
20	2.360	401/8		1/4 3/8	730	1.67	2.5 2.8				-			
10	1.975			1/2	740	7.19	3.0							
20	1.775	40 5/B	4.14	3/4	750	2.43	3.3	3						
20	1.540	41/16	5.37	1 3/16	759	2.66								-
20	1.234	41 /16		13/8	774	2.77 2.87			i					
20	0.800	415/8		1 13/16	792	2.93								
00	0.500	142	9.59	23/16	807	3.00	3.9	0				ļ		-
						FOU	IDE B	Y Bucc	1446					
						MILL	TE O	1 3020	I NO.					



	UNIVEDEP TO SOIL	of C MECHA	NICS	ENG	BORAT	RING		LOCA1	E h			21T -				
ach	ne Da	ta:-						Desc	ript	ion	of S	ample:				
achi	ne No							NATIVE	5	RAI	iEN H	11TH 49	0 OF - 1	200 K		
	olicatio					1		_C	MP	AC.	TEO	AT OP	TIMUN	Mo.	ISTUR	E
t. Lo	ading	Block -	+ Pist	on (gr	is.) 21	Agm										
					SPECI	MEN			DAT	Α						
Spec	imen N	lumber					ı	2			3	4	5		6	
Late	ral P	ressur	e (	57× ) 1	gm/59	cm	0.30									
Leng			i	nches			241/2									
Are	)			q. cms.			730						1			
Volu			_0	. C. S.	cu. ft		1.604	1					-			
	Unit We						130.5	-								
3s=					· 8wo	et .	136.5	5		-						
	are +															_
	are +		Wate	r at	end		454			1/		1/	-	2	/	
_	are +		. h 4 f	Tar			435			WE	1 DOIL	USED	21	9 /	bs.	
	ber an	a werd	int of	lare			28:			-			-	-		-
A 1-	Soil	Weigh	+ of v				4068						+			-
3efo	re	Moist								-			+	-		-
Tes	t -	Degre								-			-			
		Weight			311011		188			-				-		
Aft	1	Moistu			·		4.62	,					-			
Tes	i†  -				ition	%	43	<u> </u>					1			_
ad					Load						Load					=
חו	Dial Rdg	Strain	Area		0.8	Dial Rdg		Area	5.		on	Dial Rdg	Strain	Are	0 0	ī
an	itag			7	Pan	1109	-	-			Pan	itag			-	
m	Ins.	0/0	cm²	Kamlom	Kamlom										-	
				<i>'</i>	/											
2	0.967	-	730	.03	.33		_	-	-						-	
20	0.964	.01	11	.17	.60			+		$\dashv$					-	
20	0.945	.09	11	.44	.74											
20	0.935	,/3	731	-58	.88			4							-	
20	0.925	.17	731	171	1.01			+	-			-			-	
20	0.915	·21	731 732	.85	1.13		-	-	-	-					-	
20	0.895	.29	732	1.12	1.42											
00	0.886	-33	732	1.26	1.56										-	
00	0.875	38	732	1.39	1.69				-							
00	0.862	.49	733	1.53	1.83							i			-	
00	0.828	.57	734	1.80	2.10											
00	0.803	.67	735	1.93	2.23								-		_	
20_	0.745	1.56	736	2.16	2.31			-	-			-		-	+	
00	0.586	1.36	171	7.10	176				1							
						FAILL	IEE B	BULG	NG				10 2000			
-		-							-							
-		-	!					-	-			-			-	
			-			A VIII VIII A 7										Market Market



U	NIVE	RSIT	YO	f A	LBER	ATA		PROJE	CI_	•				-
		of C						SITE	E 1./	. 1. 53	2	MIXTUR	- # 7	_
		MECHA						LOCAT		NGEK	P// -	MIXIOR	E " Z	-
												DEDTU		-
1	RI-A	XIAL	CC	MPH	RESS	ION		TECHN	LICIAN	150	il.	DEPTH DATE 2	11/59	-
a bia	- 0-	A											7 7 7 7	-
chin	e Da	10:-	-	T-0				Desc	ripilo	<u>n or 5</u>	ample:	OF - #200	0	_
								1						
		on Fac							MPA	CTED	AT C	PTIMUM.	MOISTUR	E
. Loa	ding	Block -	+ Pist	on (gr	15.)	1 /91	n.							_
					SPECII	MFN		1	DATA					-
pacia	man A	Number	,				1	2	-	3	4	5	6	-
					/ /								0	-
		ressur			gm/sg.	cm	0.60					-	-	_
engt	h			nches			24						-	_
rea				q. cms.			730							_
olun					cu.ft		1.57	/						
		eight			t. 8d		.132.0	)						
s=	۰۷٥	olume	Soil	Solids	5 Ywa	9+	138.	/	L	VET SOIL	USED	217	165.	
		Soil +												
		Soil+					437	5						_
	re +						4/9							Т
			the of	Taro								+		****
		d weig	ini or	lare			23		-			-	-	
/t. S	011						3960	0				-	-	
efor	e	Weigh											-	
Test	1	Moistu	ire c	onten	†									
1631		Degre	e of	satur	ation									
Aftei		Weight	ofv	vater			177							
	- 1	Moistu	re c	ontent			4.57	7						
Test	1	Degre				%	45							-
	===													Ξ
	Dial	Strain	Area	077	Loga	Dial		n Area	5.	Load	Dial	Strain A	real or	
ın	Rdg		7 11 0 0	7111	Pan	Rdg				Pan	Rdg			
					4,	,								
m.	175.	%	cm2	Kam/cm2	Kamlom									
					/							-		
	0.951	-	730	.03	.63		-							
	0.943	103	730	,30	.90									_
	0.922	1.12	731	·58	1.18		-	-			-			
	0.903	.20	731	1.12	1.72			-	{		<del> </del>			
	0.874	.32	732	1.40	2.00		-							-
	2.860	.38	732	1.67	2.27									-
	0.847	.43	733	1.94	2.54									_
	0.834	.49	733	2.21	2.71									Pilled I
00 0	1.821	154	734	2.48	3.08									
00 0	.805	.61	734	2.75	3.35									
00 0	2.781	1 .71	735	3.02	3.62									_
_	2.725	.94	737	3.29	3.89					-	ļ			
00 0			739	3.41	4.01							-		
THE RESERVE AND PERSONS NAMED IN	0.662	1.20				3					1	1		
		1.69	742	3.52	4.12									
THE RESERVE AND PERSONS NAMED IN	0.662					Fau	UPE	RV PILL	ING					
THE RESERVE AND PERSONS NAMED IN	0.662					FAIL	URE B	84 8UCG	ING.					
THE RESERVE AND PERSONS NAMED IN	0.662					FAIL	URE B	84 806	ING.					
THE RESERVE AND PERSONS NAMED IN	0.662					FAIL	UREB	84 8066	ING.					
THE RESERVE AND PERSONS NAMED IN	0.662					FAIL	URE B	84 8066	ING.					
THE RESERVE AND PERSONS NAMED IN	0.662					FAIL	URE B	84 806	ING.					



	UNIVE	RSIT	Y 0	f Al	BEE	ATS		PROJE	CI						
		of C						SITE	-	. /	1.	. 52		7	
											JGER	PIT	- N	IXTO	1KE # 2
		MECHA						LOCAT					DEDTI		
	TRI-A	XIAL	CC	OMPF	RESS	ION		TECHA	LICLA	\ AL	211	it.	DATE	2/	150
															37
	ine Da		-;	-0				Desc	ript	ion	of S	ample:	-#	7	7
		•		.0								1TH 4%			
		on Fac						COM	PAC	TE	DA	T OPT.	IMUM	1410	ISTURE
. Lo	pading	Block -	+ Pist	on (gm	1s.)	Kgr	7.								
					SPECI	MEN		1	DAT	Δ					
0.00	cimen	Number			0. 201		ı	2			3	4	5		6
				- \ \	V 1.								1 - 3		0
		ressur	8 1	nches	19m/31	.cm	0.90			-			-	-	
	gth_						24 1/1	6		-			-		
re				q. cms.			730						-		
	u m e			C- 8-			1.575			-			-		
		eight					/32.3								
s =		olume					138.4	7							
		Soil +										.,	-		
		Soil +	Wate	r at	end		424			WE	TSOIL	USED	21	8	165
	Tare +						407						-		
um	ber ar	d weig	ght of	Tare			23	8							
11.	Soil						373	2							
940	ore	Weigh	tof	water											
		Moistu	ire c	onten	t										
Te	51	Degre	e of	satur	ation										
	er	Weight					173					*			
				ontent	ì		4.60								
Te	ST			saturo		%	46								
=		7						7		-		1	1 7		_
br	Didi	Strain	Area	07-	Load	Dial		n Area	5.		Load	Dial	Strain	Are	0 01
n	Rdg			4111	Pan	Rdg					on Pan	Rdg			
			-		41			-					-		
m	173	%	Cm2	Kamlon	Kgm/cm		-			-			-		
	0.987	-	730	.03	.93				-	-			+		
2	0.961		730	.58	1.48				-			<b> </b>			
0	0.936		73/	1.12	2.02										
20	10.914	.30	732	1.67	2.57										
	0.892		733	2.21	3.11					_					·
	0.866		733	2.76	3.66			-		_					
	0.852		-	3.03	1		-								
	0.833			3.30	4.47		-	+				<del> </del> -	-		-
	0.784		736	3.83	4.73			+		-					
	1			4.10	5.00	<del></del>									
0	0.701	1.19		4.23	5.13							1			
	0.645			4.35	5 25										
	10.560			4.47	5.37	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,									-
12	10.385	2.50	148	4.54	5.44										
-					FAIL	VRE	By B	UZGING	-						1
-	1	1			11			1	-			1			
L															
-	-			-	-			-					-		
-	-	-	-			-		-	-				1		
-	and the same of the	THE ROLL OF THE PARTY.	J		44	in management	-	a contra recommendadores	electronia w	-		Lay wasperson	THE RESIDENCE OF THE PERSON NAMED IN	MATERIAL PROPERTY.	THE REAL PROPERTY.



PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT . MIXTURE #2 SOIL MECHANICS LABORATORY LOCATION HOLE DEPTH TRI-AXIAL COMPRESSION TECHNICIAN B.C. Al. DATE 26/1/59 achine Data:-Description of Sample: NATIVE GRAVEL WITH 4% OF - \$200 REMOVED achine No.\_\_\_\_ ultiplication Factor\_ COMPACTED AT APPROX. 6% MOISTURE Loading Block + Piston (gms.) 21 Kgm FELT LINER & CIRC. GAUGE USED SPECIMEN DATA 1 2 3 4 5 6 pecimen Number (0Th ) Kam. /59. cm ateral Pressure 0.30 24 3/8 inches ength 720 rea sq. cms. C-C-S- cu.ft olume 1.573 ry Unit Weight Ibs/cuift. Xd 134.1 s= · Volume Soil Solids Xwet 142.0 It. Tare + Soil + Water at start It. Tare + Soil + Water at end 5290 5033 WET SOIL USED 223/2 16s. 11. Tare + Soil umber and weight of Tare 655 11. Soil 4378 Weight of water efore Moisture content Test Degree of saturation Weight of water 257 After Moisture content 5.87 Test Degree of saturation 62, 1 d Load Load Dial Dial Dial Strain Area Strain Area Strain Area or OT on 0. On Rdg Rdg. Rdq. Pan Pan n DC. AD DIAL CIRC. STRAIN AREA VI-VIII ROG ROG cm? Kam/cm2 Kam/cm 105. 115. % Ins. 397/8 720 2.969 .03 .33 .47 2.965 .02 .17 .61 п .31 0 2.953 .07 2.932 11 .45 .75 0 .15 2.908 10 .25 40 .58 .88 0 1.02 0 2.880 .37 ıŧ .72 2.850 3915/16 .41 723 1.16 0 1/16 .86 0 2.818 .62 1/16 723 1.00 1.30 1/8 2.777 40 .79 725 1.13 1.43 0 401/16 .99 2.727 3/16 728 1.27 1.57 0 2.665 40 1/8 1.70 1.25 1/4 1.40 0 730 0 2.590 40 1/4 1.56 3/8 735 1.53 1.83 1.95 1.99 740 10 2.485 40 3/B 1/2 1.65 11/16 0 2.258 40 9/16 2.92 747 1.77 2.07 0 1.670 417/8 5.33 799 1.78 25/8 2.08 20 1.330 421/2 825 1.75 2.05 6.72 FAILVRE 84 BULGING.



UNIVERSITY of ALBERTA DEPT of CIVIL ENGINEERING	PROJECT SITE SAMPLE WINGER PIT - MIXTURE # 2 LOCATION
TRI-AXIAL COMPRESSION	HOLE DEPTH TECHNICIAN 15.0. M. DATE 26/1/59.
ichine Data:- Ichine No	Description of Sample: NATIVE GRAVEL WITH 4% OF -#200 REMOVED
Itiplication Factor	COMPACTED AT APPROX 6% MOISTURE
. Loading Block + Piston (gms) 21 Kgm	FELT LINER & CIRC GAUGE USED.

	The second secon						
	SPECIMEN		D	ATA			
pecimen N	umber	I	2	3	4	5	6
ateral Pr	essure (on ) Kam/sz.cm.	0.60					
ength	inches	245/8					
rea	sq. cms.	720					
olume	cors. cu.ft.	1.591					
ry Unit We		134.9					
s= ·Vol	ume Soil Solids Ywet	142.7					
t. Tare + S	oil + Water at start						
t. Tare + S	Soil + Water at end	4398		WET SOIL	USED	227	165.
t. Tare + S	oil	4187					
umber and	l weight of Tare	612					
t. Soil		3575					
efore \	Weight of water						
Test	Moisture content	<u> </u>	<u> </u>				
1631	egree of saturation						
After \	Neight of water	211					
Test 1	Moisture content	5.91	<u> </u>				
[	Degree of saturation %	65					
od Dial n Rdg	Strain Area or Load Dial		Area	C. Load on Pan	Dial Rdg	Strain A	rea 57
10 DIAL ROG	CIRC STRAIN AC AREA YI - YII	, V.					
K DG1	KUG						
	0/	21///				T	

n in	Rdg	Strain	Area	Oī	on Pan	Rdg	Strain	Area	0.	Pan	Rdg.	Strain	Area	61
90	DIAL	Cine	STRAIN	AC	AREA	Y - 7111	Υ,					-		
20	ROG	RUG	DIKAIN	4	TIKEH	11-4111	11					-		
	RUG	RUG												
77	105.	195.	%	105.	cm²	Kgm/cm2	Kam/cm²							
						<u>'</u>	'							
>	2.932	39 15/16	-	_	720	. 03	. 63							
0	2.918	11	.06	-	- 11	,31	1 .91						+	- P
00	2.885	"	.19	~	"	.28	1.18							
0	2.841	40	'37	1/16	723	.86	1.46							
70	2.789	11	.58	1/16	723	1.14	1.74							
20	2.733	40 1/16	.81	1/8	725	1.41	2.01							
20	2.660	40 1/B	1.11	3/16	728	1.68	2.28							
.00	2.576	403/16	1.45	1/4	730	1.95	2.55							· ·
00	2.450	405/16		3/8	735	2.21	1 2.81							}
00	2.253	40 5/8		11/16	747	2.44	3.04							
00	2.113	40 13/16		7/8	755	2.55	3.15							é
00	1.820	41 1/4	4.52	15/16	772	2,62	3.22						1	
30	1.530	413/4	5.69	1 13/16	792	2.59	3,19					-		
						Fall	RE BY	Ruce	1016					1
						777720	ne of	NULG	7700.					
		1					1	l		1		-		
		1	-				-			1				1
		<del> </del>				1				1				
-														



														-
	UNIVE DEP TO SOIL	of (	CIVIL	ENG	INEE	RING		LOCAT	E W		Pit -			
	TRI-A	XIAL	. CC	MPF	RESS	ION		HOLE	ICLAI	1 60	M	DEPTH	2.7.	10
-													26/1	/59
ach	ine Da ine No	<u> 1 a :-</u>	7	-0				VATINE	riptio	on or S	ample:	25 - #7/	In RE	44.450
	olicatio										APPRUX.			
	ading				e) 2	1 Kan					CIRC			
1. LU	ading	BIOCK	T   1311								0/20			
					SPECII	MEN		[	DAT	7				
	imen I							2		3	4	5		6
	ral P				gm. 150	7.cm.	0.40					-		
	1th			ches			24 5/	8						
tre				q. cms.	0		720					-		
	m e			. C-5-		:	1.59					-		
	Unit W			bs/cu.f			137.0							
	۰۷٥					<u>:</u> †	145.0	2						
	Tare +						484	,		VET SOIL	1/	22.	0.5 /	/
	Tare_+		WUIE	41	enu		4600			YET SOIL	USED	230	7,5 /	55.
	ber an		abt of	Tara			646					-		
	Soil	a well	giii oi	Ture			3960					-		
		Weigh	t of v	unter			3760				!	-		
3efo			ure c											
Tes	it		e of					_				-		
A			t of w				235							
Aft			ire co		-		5.94							
Tes	51		e of			%	70							
a d	01-1				Load	0:-1		T		Load	0:-1			
กาก	Dial Rda	Strain	Area	07	Pan	Dial Rdg		Area	0.	Pan	Dial Rdg.	Strain	Are	2 61
90			STRAIN	DC	AREA	VI - VIII	A.							
	ROG	ROG									<u> </u>	-		
יאין	ins.	103	0/0	175.	Cm²	Kanlon	Kgm/cn	2						-
	7.7.5					1.47.0	7.70							
2	2.990	3915/16	7		720	.03				_				
20	2.979		.05	~			1.21		-			-		+
20	2.956	"	.14		- 11	.58				-	-			
20	2.887	и	.42	-	0	1.14					Ì			
00	2.842	40	1 60	1/16	723	1.41								
00	2.791	-		1/8	725	1.68	2.58							-
00	2.733	401/8		3/16	728	2.22	ينفحه فتنشأ أنند				1			
100	2.579			11/32	734	2.48				-	1			
00	2.467	40 13/37	2.12	15/32	739	2.74	3.64	L						
200				3/4	750	2.96	1			-				-
200	2.182			15/16	757	3.07								
00	1.845		4.65	17/8	794	3.17					J			
000	1.525	421/8	5.95	2 3/16	807	3.25						1		
1.65	0.785	43 5/8	8.95	3 "/16	869	3.09	3.9	9						
-		-			-	FAI	LURE	BY BUL	GINI	5		-		
-	-		- Annual Control			1 / / / /	7				<del></del>			The second second



	UNIVE	RSIT	Υ 0	f Al	BER	AΤΣ		PROJE	CI				
		of (						SITE	-	/	77	2.1	*
								LOCAT		INGER	PIT -	MIXTU	RE#3
		MECHA						HOLE				DEDTU	
	IRI-A	XIAL	C	MPF	KESS	NOI		TECHN	ICIAN	1 B.a.	Int.	DEPTH DATE 9	1,159
ach	ine Da	t a:-								n of S			
achi	ne No			7.0				NATIVE	JRA	VEL WI	TH 6%	OF - \$200	REMOVED
		on Fac										UM MOI	
		Block			(s.) Z	1 Kg.	n						
					SPECII	MEN			DATA				
_		Vumber					-	2		3	4	5	6
		ressur			19m/5	1.Cm	0.30					-	-
	ith			nches	····		24		-			· ·	-
re	m e			q. cms.		4	730					<b> </b>	-
	Unit W	eight.		bs/cu-f			135.0						
S=	• V	olume				- t	141.2						
-		Soil +					1-41.2			NET SOIL	1/sen	222	165
		Soil +					491	4		7.27 3012	USEU	AZZ	1703.
-	Tare +						4 72						
		d weigh	aht of	Tare			669						
-	Soil		4111	1010			4052						
		Weigh	t of	water			7.5.5						
efo				onten									
Tes	1			saturo									
Aft	er	Weight					193						
Tes		Moistu	ire c	ontent	1		4.76	,					
163	1	Degre	e of	saturo	ition	%	52						
ad	Dial	T			Load	Dial		T		ILogd	Dial		
n In	Rda	Strain	Area	01-	on Pon	Rdg		Area	0.	Pan	Rdg	Strain A	rec or
-	,	-			4		-			1 311			
m	Ins.	0/0	cm²	Kamlom	Kamlen	2							
							-	-					
0	0.994		730	.03	.33			-					
10	0.980		730	30	.60								
0	0.969		73/	.44	.74								
20	0.957	.15	731	.58	.88								
00	0.945		731	.71	1.01			-		-			
0,0	0.921	.24	732	.99	1.29				-	1		1	
20	0.909	.34	732	1.12	1.42								The second secon
20	0.897	.39	733	1.26	1.56								
20	0.882	.45	733	1.40	1.70		-						
00	0.860	.65	734	1.53	1.83		-		-				
20	0.777	.87	736	1.79	2.09								
75	0.600	1.64	742	1.88	2.18			1					
-		-	-			Fau	IDE P	Y BULL	\$ 1016	-			
-		<del> </del>				I FAILL	000	10020	1110				
-		-	}	-					-				
-							CONTRACTOR V						



	ININ	PCITY	v -	£ 01	DED	PROJECT													
	UNIVE							SITE SAMPLE WINGER PIT MIXTURE #3											
	DEP T										VII	VGER	PIT	· Mix	TU	€€_	#3		
	SOIL	MECHA	NICS	LA	BORAT	ORY			CAT										
	TRI-A	ΧΙΔΙ	CC	MPE	RESS	ION		HO	OLE				1	DEPTH					
	11117			71411 1	1200	1011		HOLE DEPTH TECHNICIAN B. a. M. DATE 9/1/5											
	ine Da							Description of Sample:											
ach	ine No		7	TO.				NATIVE GRAVEL WITH 6% OF - \$200 REMOVE											
ulti	olicatio	on Fac	tor						co.	MPH	00	TED	HT CI	PTIMUM	1 12	1013	TURE		
	ading				s.)2	1 491	n .												
								1			_			•					
					SPECII	MEN				TAC	<u>A</u>								
	imen 1						- 1	_	2			3	4	5			6		
_ate	ral P	ressur	e (	57x ) A	1gm/59	. cm	0.65												
_eng			i:	nches			24 3/	8											
Are:			S	q. cms.			730												
	m e			-Crs.			1.597	,											
	Unit W	eight					/33.5												
_	· V					- t	139.8									-			
	Tare +					137.8	2						-						
	are +						418	,											
						-	1./		((	2.5		165							
	Tare +		400:				WE	T 2014	USED	223	-	105	S						
	ber an	d weig	the of	Tare			22.	-											
Nt.	Soil						3782	2											
3efo	re	Weigh	t of v	water															
Tes		Moistu	ire c	ontent	}														
168		Degre	e of	saturo	ation														
Aft	0.5	Weight	ofv	water			181												
				ontent			4.7	9											
Tes	51			satura		0/2	50												
								'								==			
a d	Dial	Strain	Area	0-	Logd	Dial		$n \mid A$	real	0.		Load	Dial	Strain	Ar	eal	51		
10	Rdg			4	Pan	Rdg				-		Pan	Rdg∙						
					4.														
m	105.	%	cm2	Kamlom	Kam/cm			_			_								
		-		,	<u></u>			+								-			
)	0.913		730		.68			+-								-			
20	0.905	109	730	·30 ·58	1.23						$\dashv$					-			
20	0.877	114	731	-35	1.50		1	-			-					-			
	0.862				1.77		1	-			-								
20	0.847	126	732	1.40	2.05														
20	0.829	.34	732	1.67	2.32											i			
00	0.811	.41	733	1.94	2.59														
20	0.793	.48	733	2.21	2.86			_		-	_					j			
00	0.767	158	734	2.48	3.13			-			4								
00	0.735	.71	735	2.75	3.40		-							-					
	0.694	1.88	736	3.02	3.67			-			-			-					
	0.660	1.01	737	3.15	3.80						anc a.g.			-					
	0.520	1.57	742	3.40	4.05			-								1			
	0.345		747	3.50	4.15			1											
						FAIL	URE	BY	BUL	GING	÷.								
														1					
-		-						_			_			-					
-		-	1																



LIM	IVE	RSITY	1 0	f Al	BEE	TA		PROJE	CT					
	tume  v Unit Weight  v Volume Soil Solids  v Volume Soil Solids  v Tare + Soil + Water at start  v Tare + Soil + Water at end  v Tare + Soil  mber and weight of Tare  v Soil  fore  est  Moisture content  Degree of saturation  veight of water						SITE							
										VINGER	PIT -	MIXT	TURE	3
								LOCAT				DEDTI		
TF	RI-A)	KIAL	CC	)MPF	RESS	ION		TECHA	LICIA	N /5 /	m.	DATE	9/1	150
													-///	7 3 7
chine	Na	u:-		TO				Ver	ripii	On OT	Sample:	25 - #2	n Pe	MO.150
											T CPTI			
					(c) 2	1 4.00		<u>Com</u>	PHC	100 4	1 0011	10101	1073	TORE
Louid	ing c	JIOCK -	FISI	on (gii	15./									
					SPECII	MEN			DAT					
					7			2		3	4	5		6
		essur			gm/59.	cm.	0.90				1	-		
ength							24				-	ļ		
rea			S	q. cms.			730				-	-		
			С	· C. S.	CU. +	<del>*</del> .	1.512				-	-		
y Uni	1 We	ight	1	bs/cu-f	1. 80		139.1							
						+	145.	7				-		
														-
			Wate	r at	end		438			1./ (	1//		1	,
				<b>T</b>			418			WET SOI	4 USED	22	9 11	55.
		weig	int of	lare			2/3							
1. 50		Mai -	4 - 4				3973	3			-			
efore					A						-	-		
est												-		
					ation		192				+	-		
fter					,									
Γest						0/	4.84	-			-			
		Jegre	01	Suluit			62							
		Strain	Area	07-	വര	Dial		n Area	5.	Load	Didi	Strain	Arec	01
n R	dg				Pan	Rdg				Pan	Rdg			
		01	- 2	V 1 3		2		-	-			-		-
2 //	75.	70	Cm	Kam/cm	Kgm/cm		+							+
1.	003	-	730	.03	.93									
	993	.04	730	.44	1.34									
	976	. //	73/	.85	1.75		-	-			-	-		-
	959	.75	731	1.26	2.16		-	-	-		-			-
	919	·25 ·34	732 732	1.67	2.98		-		-			1		<del> </del>
0 0.		.42	733	2.48	3.38									
20 0.	868	.54	734	2.89	3.79				-					
20 0.		·73	735	3.29	4.19		-		-		+	-		-
20 0.	759 687	1.26	737	3.69	4.59			-						-
	632	1.48	741	4.08	4.98		-	1	1		+			
	558	1.78	743	4.20	5.10									
0 0.	350	2.61	750	4.28	5.18							-		
						EALL	UPF D	Y BULG	tare		-	-		
						FA16	120	JUULG	IVG.		1			1
									-	_  _			-	
							-	-	-	-	-	-		+
			i .	1	i t	1			1			1		



								,								
	UNIVE	RSITY	Y 0	f Al	BEE	TA		PROJ	ECT							
	DEP T							SITE			,	6				-
										V/A	SGER	PIT	- MIX	TUR	E	-3
	SOIL							HOLE					DERTH			
	TRI-A	XIAL	CC	MPF	RESS	ION		TECH	NICLA	N	B. a	W.	DATE	291	11	59
10h	ine Da	t a:-										ample:			-/-	
1 Chi	ne No	<u> </u>	7	T.O.				NATI	VE G	RA	UFI.	WITH .	6 0/0	OF	_ ;	# 700
	olicatio				_							NPACTE				
	ading				(s) 2	1 Kam						CIRC.				
	a a m g							1								
					SPECII	MEN			DAT	A						
	imen M				, ,				2		3	4	5	-		6
-	ral P	ressur	e (c	17K) K	gm./59	I. Cm.	0.30						-	-		
	th_			nches			243/	4		-						
red	m e			q. cms.			720						-	-		
	Unit W	eight.		hs/cu.f		-	1.600	تتسحد بالمتنا		-						
s=		lume				a t	145.			-			-			
-	are +					= 1	143.	<del></del>				5		-		
	are +		612	,		4/0	T SOIL	USED	23	3	165					
	ore +		11010		0110		519			W.C.	7 0012	0300	1 23		103	•
-	ber an		tht of	Tare			74									
	Soil	4 11011	1117 01	1010			5050						1	_		
		Weigh	t of v	vater			0000									
efo		Moistu														
Tes	1	Degre														
\ft	0.5	Weight					329									
		Moistu					6.51									
Tes				satura		%	77									
2 d	2: 1				Load	0: 1		T			Load					
n	Dial Rdg	Strain	Area	01	on	Dial Rda	Strai	n Arec	5.		on	Dial Rda	Strain	Ar	eal	51
n	itag				Pan	redg	-		-		Pan	ixag	-		-	
AD	DIAL	CIRC.	STRAIN	ΔC	AREA	41 - 411	14.	1	+						-	
	ROG.	ROG.							Ţ							
		-				10 1		2					-		-	
100.	ins.	175.	0/0	Ins.	cm	Kamlom	Kam/c	M	-		-					
	2.935	40	-	_	720	.03	.33	1								
2	2.928		.03	-	720	.17										
0	2.894		.16	-	720	-31	161				-		-		-	
0		401/16	·32 ·51	1/16	723	.44	·74					-				
0		40/16	.70	1/16	725	.72	1.02		-							
0	2.707		-	1/8	725	.86	1.16									
0_		40 3/16		3/16	728	.99	1.24									
10_		40 1/4		1/4	730	1.12	1.4								-	
20	2.327	40 3/8		3/8	735	1.38		-	-			1				
	2.162		1	5/8	745	1.51										
20	1.798	141 1/B	4.55	1/8	764										_	
1	0.412	43	10.09	3	840	1.72	1 2.0	2	-				-			
20	-		-			FAIL	URE R	Y BUL	GING			<del> </del>				
	i														j	
											-					



		RSIT					PROJECT											
		of C					SAMPLE WINGER PIT - MIXTURE #3											
S	OIL	MECHA	NICS	LA	BORAT	ORY		LOCATION										
T	RI-A	XIAL	CC	MPF	RESS	ION		HOLE			- 7	-/	DEPTH					
								TECHNICIAN A. DEPTH DATE 29/1/5										
chir	e Da	ta:-		To				Description of Sample:										
								NATIVE GRAVEL WITH 6% OF - \$200 REMOVE.  COMPACTED AT 6.5% MOISTURE										
		n Fac			-1 2/	4												
Loa	aing	Block	+ PIST	on (gm	18.1_~/	Mgm.		PEL.		YER	4	CIRC	GHU	G E	USE	<i>U</i> .		
					SPECII	MEN			TAC	7								
		lumber					1	2		3		4	5		6			
		ressur			gm/39	CM.	0.60	-					-					
engt				ches			243/4						-			_		
rea				q. cms.		,	720						-					
olur		i a b 4		- C. S.			1.600						-					
		eight olume				,	138.0											
		Soil +				<i>T.</i>	146.9			1/5-	Carr	USED	2	36	4-			
		Soil +					7430	2		VE 7 -	DOIL	USED	1 7	35 /	05.			
		Soil	11010		end		7043						-	-				
		d weigh	tht of	Tare			896											
t S		,,,,,,,	01	, 4, 6			6147											
		Weigh	t of v	vater												1		
efor	0	Moistu			}													
Test		Degre																
fte		Weight					397											
Test		Moistu					6.46											
1031		Degre	e of	satura	ition	%	80											
ıd	Dial				Load	Dial	7				ad	Dial			T			
	Rdg	Strain	Area	Oī	Pan	Rdg	Strain	Area	0.		an	Raig	Strain	Are	0	1		
	DIAL	CIRC	%	Δζ	AREA	V V.	, V,								1			
-	ROG.	RUG	STRAIN				-	-							-			
7.	105.	Ins.		105.	cm²	Kamlem	Kam/cm	2		-					-			
						1	7											
		40 5/16	1	-	720	. 03	_			_  _					-			
		40 5/16		- 1/11	720	.31				-					+			
0		40 3/8	.76	3/16	728	· 58		فتناصف الأنا							-			
0	2.700			5/16	735	1.12	1.72								I			
00		40 3/4		7/16	737	1.38	1.98											
00	2.426			5/g	745	1.64									-			
	20 2.251 41 3/16 2.97 7/8 755 1.88 20 2.009 41 9/16 3.94 1 1/4 769 2.11					2.11	2.48											
	1.640	421/8		1 13/16	787	2.32	-									-		
	1.000	431/4		2 15/16		2.42		-										
	0.690	433/4	9.22	37/16	859	2.47	-	- 1		-		-			-			
	0.000	45	11.98	4 1/16	912	2.50		}										
	Transportation had believe we are					FAILU	RE BY	BULGI	NG.						-			
		+					-	-		-11-					-			
															1			
															ralm ma	January Jo		



PROJECT UNIVERSITY of ALBERTA SITE DEP T. of CIVIL ENGINEERING SAMPLE WINGER PIT · MIXTURE #3 SOIL MECHANICS LABORATORY LOCATION TRI-AXIAL COMPRESSION HOLE DEPTH TECHNICIAN 5 d M DATE 29/1/59 achine Data:-Description of Sample: NATIVE GRAVEL WITH 6% OF #200 REMOVED achine No.\_\_\_ ultiplication Factor COMPACTED AT 6.5% MOISTURE t. Loading Block + Piston (gms.) 21 Kgm EELT LINER & CIRC. GAUGE USED SPECIMEN DATA Specimen Number 1 2 3 4 5 6 \_ateral Pressure (OTK) Kam. /59. cm. 0.90 ength inches 243/8 Area sq. cms. 720 C.C.S. Cu. ft. /olume 1.573 ry Unit Weight Ibs/cu.ft. Xd 138.5 is= · Volume Soil Solids 8 wet 147.4 Vt. Tare + Soil + Water at start WET SON USED 232 165 Vt. Tare + Soil + Water at end 5585 5284 N1. Tare + Soil lumber and weight of Tare 673 Nt. Soil 4611 Weight of water Before Moisture content Test Degree of saturation Weight of water 301 After Moisture content 6.53 Test Degree of saturation % 82 ad Load Load Dial Dial Dial Strain Area Strain Area Strain Area Gi on Pan 01 on Pan Rda Rda Rdg. חנ CIRC. STRAIN AD DIAL AC AREA V. - VIII ROG ROG 105. 0/0 cm2 Kam/cm2 Kam/cm 3m. ins. 39 3/4 2.963 720 -03 .93 2.989 393/4 .14 .31 1.21 70 720 2847 39 13/16 .48 1/16 723 ,58 1.48 20 39 7/8 2.745 .90 1/8 725 .86 1.76 20 39 31/32 729 2.03 7/32 1.13 2.632 1.36 20 2.29 00 2.502 40 1/8 1.89 3/B 735 1.39 2.367 401/4 1/2 740 1.65 2.55 2.45 00 5/8 2.209 403/8 3.09 745 1.91 2.81 00 13/16 00 2.048 40 9/16 3.76 752 2.16 3.06 15/16 2.40 1.867 40 13/16 4.50 757 3.30 00 1.645 411/4 5.41 11/2 00 779 2.60 3.50 200 1.240 423/81 7.08 25/8 825 2.69 3.59 3 1/4 9.33 001 0.690 43 851 2.73 3.63 43 15/32 3 23/32 10.93 872 2.78 3.68 0.300 200 0.000 441/2 12.18 43/4 915 3.63 FAILURE BY BULGING



1	UNIVE	RSIT	YO	f Al	LBER	ATA		SITE	VI.							-
	DEP T.	of C	IVIL	ENG	INEE	RING	SAMPLE WINGER PIT . MIXTURE #4									
	SOIL							LOCAT						- /0 6		
	TRI-A											/	DEPTH			
	HINH	NIAL	00	MAIL L	123	IOIV		TECHN	ICIA	N/	BU.	W.	DATE	6/1	159	
lach	ine Da	t a :-						Desci	ripti	on	of S	ample:				
	ne No-							NATIV	Ē G	RA	VEL (	-RUSH	ED TO	2"		
	olicatio							Comi	PACT	ED	AT	OPTIM	um N	10151	URE	E.
t. Lo	ading	Block -	+ Pist	on (gm	rs.)	?1 Kg.	٠٠٠									
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Are				q. cms.			730						1			
	m e			-C. S.			1.604									
	Unit We	eight		bs/cu-f			128.4									
	· Vo					+	135.3									
	Tare +															
	are +						439:	5								
	Tare +						4184	Z		WE	T 5012	USED				
	ber an		tht of	Tare			238									
	Soil		•				3946									
Befo		Weigh	t of v	water												
	1	Moistu			1											
Tes		Degre														
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20	0.887	.19	731	.56	.86											
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00	0.808	.50	734	1.25	1.55			1		1					1	
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20_	0.715	1.15	736	1.79	2.09								-		-	
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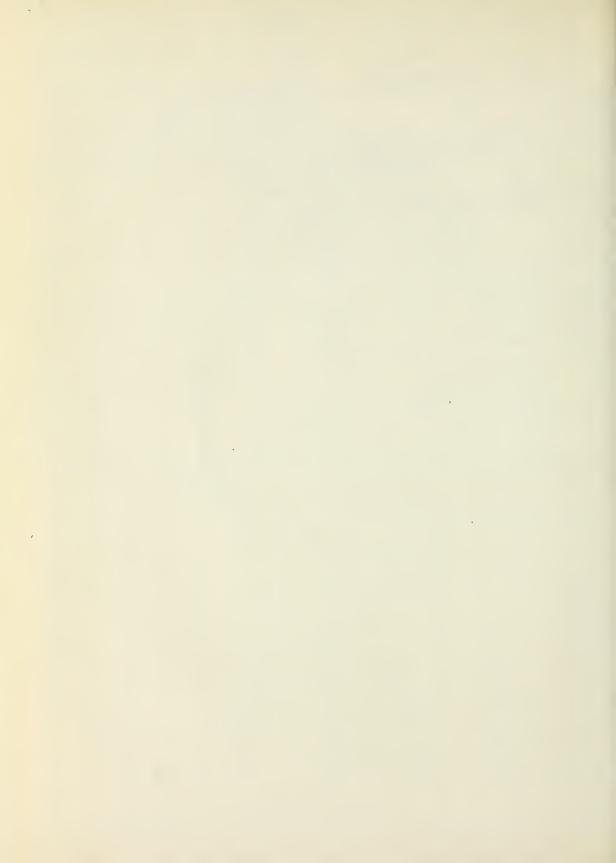
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00	0.848		732	1.39	1.99		-					1						
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-				VIII.	on Pan		Strain	Area	51		on		Strain	Area	01
m.	ins	0/5			on Pan		Strain	Area	51		on		Strain	Area	81
m.				VIII.	on Pan		Strain	Area	5.		on		Strain	Area	81
2 00	1.994 1.976	°/ <sub>0</sub>	730	V <sub>111</sub> Kqm/cm <sup>2</sup> .03 .30	On Pan V1 Kgm/cm -93		Strain	Area	5.		on		Strain	Area	81
20	1.994 1.976 1.952	% - .07	730 731 731	Kqm/cm²  .03  .30  .58	00 Pan T1 Kam/cm -93 1.20		Strain	Area	5.		on		Strain	Area	δ.
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## PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE#4 SOIL MECHANICS LABORATORY LOCATION HOLE / DEPTH TRI-AXIAL COMPRESSION TECHNICIAN B.d. 21 DATE 23/1/59 Machine Data:-Description of Sample:\_ T.O. NATIVE GRAVEL CRUSHED TO 2" MAX Machine No.\_\_\_\_ Aultiplication Factor COMPACTED AT APPROX 6.5% MOISTURE Vt. Loading Block + Piston (gms.) 21 Kgm. FELT LINER & CIRC GAUGE USED. SPECIMEN DATA Specimen Number 2 3 4 5 6 Lateral Pressure (07%) Kgm./sq. cm 0.60 24 5/B Lenath inches Area sq. cms. 720 C.C.S. Cu. ft. 1.591 Volume Dry Unit Weight Ibs/cu.ft. dd 124.6 · Volume Soil Solids Xwet Gs= 132.2 Wt. Tare + Soil + Water at start 5043 165. Wt. Tare + Soil + Water at end WET SOIL USED 211 4788 Wt. Tare + Soil Number and weight of Tare 625 Wt. Soil 4163 Weight of water Before Moisture content Test Degree of saturation Weight of water 255 After Moisture content 6.13 Test Degree of saturation 47 oad Load Load Dial Dial Dial Strain Area Strain Strain Area Area 5. OI on on on Rdq. Rda. Rda Pan Pan an CIRC. STRAIN AC AREA VI - VIII DIAL OAD ROG Rog cm2 Kamlom2 Kamlom (gm. Ins. 0/0 115. 115 2.965 397/8 \_ 720 .03 .63 0 2.950 397/8 .31 .91 200 .06 1.18 2.932 100 397/8 ./3 .58 2.908 397/8 .23 11 .86 1.46 600 1.74 2.877 39 7/8 .35 1.14 300 000 2.837 39 7/8 .51 1.42 2.02 2.29 200 2.779 3915/16 .74 1/16 723 1.69 400 2.693 401/16 1.09 3/16 728 1.95 2.55 600 2.555 1.64 3/8 735 2.81 401/4 2.21 2.71 3/4 405/B 800 2.288 750 2.43 3.03 1 3/16 900 2.047 411/16 3.67 767 2.51 3.11 41 1/2 15/8 784 2.58 3.18 5.46 2000 1.600 25/8 825 2.57 3.17 2100 1.190 421/2 7.10 846 2.56 2140 10.900 43 8.26 3 /8 3.16

FAILURE BY BULLING



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ad	Dial	Strain	Area	C	Load	וטוע	Strain	Area	6.	Load	Dial	Sfrain A	area or	
a u	Rdg	3174111	Areu	01	Pan	Rdg	J. Turi	7,00	J.,	Pan	Rdg	3		
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DAD	RDG	ROG	DTRAIN	ΔC	AREA	V V.,	1 7		-					
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A PROPERTY OF		-	CARREST MATERIAL PROPERTY.		U	-		ar Inschange	-			-	The same and the same and	SEC. 140

PROJECT



	UNIVE	.RSIT	YO	f Al	LBER	ATS		CLT		4						-
		of C						SITE		- 1./		77		,		
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	ine Da							De	scri	ption	of S	CRUSH				
Mach	ine No			7.0.				NA	IVE	GR.	RAVEL	CRUSH	ED TO	0 1/2	" M.	AX.
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		Block -			(c) 2/	Kam						RE C				
VI. LO	duling	DIOCK	T 1 131	on (gii	13./	7//				- ///	21370	26 0	510761	V/.		
					SPECII	MEN			D	ATA						
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Aft	1						5.21						-			
	1	Moistu	re c	ontent		0/0	5.21									
Tes	1	Moistu	re c		ation	%	-									
Tes	1	Moistu Degre	re c e of	ontent satura	Load		5.21				Load	Dial	Strain	0.50		
Tes oad	st	Moistu	re c e of	ontent satura	Logd		5.21 49		· a	51	on	Dial Rdg.	Strain	Are	ea 8	7
Tes	Dial	Moistu Degre	re c e of	ontent satura	Logd on Pan	Dial	5.21 49		10	0:			Strain	Are	ea 8	ī
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Tes	Dial Rdg	Moistu Degre Strain	Area  Cm²  730	ontent saturo Oi- Viii Kam/cm.	Load On Pan	Dial Rdg	5.21 49		· a	5.	on		Strain	Are	ea s	r
Tes	Dial Rdg  /// // /// /// /// /// /// /// /// /	Moistu Degre Strain %	Area  Cm²  730  731	ontent saturo Or- Viii Kam/cm.	Load on Pan Vi Kam/cm	Dial Rdg	5.21 49		a	5.	on		Strain	Are	ea o	r
Te:	Dial Rdg  ins  0.975 0.947 0.927	Moistu Degre Strain %	re c e of  Area  Cm²  730  731	Ontent saturo Viii Kamlom. .03 .17 .30	Logd on Pan Vi Kgm/cm	Dial Rdg	5.21 49		20	5:	on		Strain	Are	ea 8	r
Te:	Dial Rdg ins 0.978 0.947 0.927 0.920	Strain  %	Area  Cm²  730  731  731  732	ontent saturo Or- Viii Kam/cm.	Load on Pan  Si Kan/cm  33  47	Dial Rdg	5.21 49		2 0	5.	on		Strain	Are	ea 8	I
Te:	Dial Rdg ins 0.978 0.947 0.927 0.910 0.894	Strain  %	Cm <sup>2</sup> 730 731 732 732 732	Ontents sature of the sature o	Load of Pan  Ti Kam/cm  -33  -47  -60  +04  + 38	Dial Rdg	5.21 49		20	51	on		Strain	Are	e a 8	Ī
Te:	Dial Rdg ins 0.978 0.947 0.927 0.920	Moistu   Degre   Strain   %	Area  Cm²  730  731  731  732	07- Viii Ngm/cm .03 .17 .30	Logd on Pan Si Kgm/cm 33 47 60 1-04	Dial Rdg	5.21 49		20	51	on		Strain	Are	e a 8	
Te:	Dial Rdg ins 0.975 0.947 0.927 0.910 0.894 0.879	Moistu   Degre   Strain   %     -12   -20   -27   -34   -40   -40	Area  Cm²  730  731  731  732  732  733	001 entents sature 007 - 1711. Kgm/em 103 - 117 - 30 - 44 - 58 - 71	Logd Off Pun  Ti Kam/cm  -33  -47  -60  + .80  1.01	Dial Rdg	5.21 49		20	G-1	on		Strain	Are	ea o	ŗ
Te:	Dial Rdg ins 0.975 0.947 0.927 0.910 0.894 0.879 0.863	Moistu   Degre   Strain   %	Cm <sup>2</sup> 730 731 732 732 733 733	001 entents sature 007 - 1711. Kgm/em 103 - 117 - 30 - 44 - 58 - 71 - 85	Logd Of Pun  Ti Kam/cm  -33  -47  -60  +04  + 380  1.01  1.15	Dial Rdg	5.21 49		0	G:	on		Strain	Are	ea o	r
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Te:	Dial Rdg ins 0.975 0.947 0.927 0.910 0.894 0.879 0.863 0.849 0.832	Moistu   Degre   Strain   %   -	730 731 732 732 733 734 734	001 entents ature 001 - 101 -	Logd Off Pun  Ti Kam/cm  -33  -47  -60  +04  + 38  1.01  1.15  1.28  1.42	Dial Rdg	5.21 49		0	6.	on		Strain	Aree		
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Te:	Dial Rdg ins 0.978 0.947 0.940 0.894 0.879 0.863 0.849 0.832 0.815 0.793	Moistu   Degre   Strain   %	730 731 732 732 733 734 734 735 735	Ontent saturo OT- VIII. Kgm/cm .03 .17 .30 .44 .58 .71 .85 .98 .71 .85 .98 .712 .725 .739	Logd Vii Pan SI Kgm/em ·33 ·47 ·60 Hod + ·80 1·01 1·15 1·28 1·42 1·55 1·69 1·91 1·92 1·94	Dial Rdg	5.21 49		20	G:	on		Strain	Are		
Te:	Dial Rdg ins 0.978 0.947 0.940 0.894 0.863 0.869 0.863 0.869 0.805 0.793 0.767	Moistu Degre Strain  %	730 731 732 732 733 734 734 735 735 736	Ontents ature  OT-  Viii  Kam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .166  .179	Logd Vii Pan Si Kgm/cm -33 -47 -60 1-04 + 80 1-01 1-15 1-28 1-42 1-55 1-69 1-82	Dial Rdg	5.21 49		20	G:	on		Strain	Are		r
Te:	Dial Rdg 1ns 0.975 0.947 0.927 0.910 0.879 0.863 0.849 0.863 0.793 0.767 0.736 0.486 0.590	Moistu Degre  Strain  %	730 731 732 732 733 733 734 735 736 737 739	Ontents ature  OT-  Viii  Vam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .1.66  .1.79  .1.92	Logd   Pun   St     Kgm/cm	Dial Rdg	5.21 49		20	G:	on		Strain	Are		r
Te:	Dial Rdg 	Moistu Degre  Strain  %	Cm²  730 731 732 732 733 733 734 734 735 736 737 739	Ontents ature  OT-  Viii  Kam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .166  .179	Logd Vii Pan SI Kgm/cm -33 -47 -60 +04 +80 1.01 1.15 1.28 1.42 1.42 1.55 1.69 1.92 1.96 2.09	Dial Rdg	5.21 49		20	G;	on		Strain	Are		T
Te:    God   God	Dial Rdg 1ns 0.975 0.947 0.927 0.910 0.879 0.863 0.849 0.863 0.793 0.767 0.736 0.486 0.590	Moistu Degre  Strain  %	730 731 732 732 733 733 734 735 736 737 739	Ontents ature  OT-  Viii  Vam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .1.66  .1.79  .1.92	Logd   Pun   St     Kgm/cm	Dial Rdg	5-21 49 Strain	Ar:			on Pan		Strain	Are		T
Te:    God   God	Dial Rdg 1ns 0.975 0.947 0.927 0.910 0.879 0.863 0.849 0.863 0.793 0.767 0.736 0.486 0.590	Moistu Degre  Strain  %	730 731 732 732 733 733 734 735 736 737 739	Ontents ature  OT-  Viii  Vam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .1.66  .1.79  .1.92	Logd   Pun   St     Kgm/cm	Dial Rdg	5.21 49	Ar:			on Pan		Strain	Are		7
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Te:    God   God	Dial Rdg 1ns 0.975 0.947 0.927 0.910 0.879 0.863 0.849 0.863 0.793 0.767 0.736 0.486 0.590	Moistu Degre  Strain  %	730 731 732 732 733 733 734 735 736 737 739	Ontents ature  OT-  Viii  Vam/em  .03  .17  .30  .44  .58  .71  .85  .98  [.12  .125  .139  .152  .1.66  .1.79  .1.92	Logd   Pun   St     Kgm/cm	Dial Rdg	5-21 49 Strain	Ar:			on Pan		Strain	Are	eq of s	



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200	1.934 1.896 1.873	-16	730 731 732	· 03 · 30 · 58	Vi Kgm/cm .63 .90										
00	1.934 1.896 1.873 1.850	-16 -26	730 731 732 732	· 03 · 30 · 58 · 85	Vi Kgm/cm .63 .90 1.18 1.45										
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	TRI-A	AIAL		אועוע	(522	NOI		TECH	NICIA	AN	5.21	ist.	DATE	30/1	2/58
Mach	ine Da	t a:-						Desc	ript	ion	of S	ample:			
Machi	ne No			1.0				VATI	JE	On	AVEL	- Exu	SHED	TO 1	12"MAX
	olicatio											D AT			
	ading					1120	2					-URE			
					SPECII	MEN			DAT	A					
	imen 1						1		2		3	4	5	-	6
	ral P	ressur	e (	nches	am 151	.cm.	0.90						-		
Leng							227/	2		-			- <del>  </del>	-	
Are				q. cms.			730			-			-		
Volu				c.s.			1.49			-					
	Unit W			bs/cu-f			123.1			-					
	٠٧٥						129.	,		-					
	Tare +									-					
	ore +		Wate	r at	end		9371			We	ET SO	16 WSB	50 19	3	165.
	Tare +						8950	<u> </u>							
	ber an	d weigh	tht of	Tare			772			ļ					
W†·	Soil						817	<u> </u>							
Befo	re	Weigh	t of v	water						<u> </u>					
Tes		Moist	re c	onten	t										
		Degre	e of	saturo	ation					<u> </u>					
	_	Weight	of w	untar			12			i				1	
ATT	er i	11 0.1 9 11	01	40101			421			-					
Aft				onteni	}		5.15								
Tes		Moistu	ire c			0/0									
Tes	st	Moistu Degre	re c e of	onteni satura	ition		5./S 38				Load	Dial			
Tes oad on	Dial	Moistu	re c e of	onteni satura	Load	Dial	5./S		0.		Load	Dial Rda	Strain	Are	0 51
Tes	st	Moistu Degre	re c e of	onteni satura	Load on Pan		5./S		0.			Dial Rdg-	Strain	Are	0 51
Tes oad on an	Dial Rdg	Moistu Degre Strain	e of Area	onteni satura	Load on Pan	Dial Rdg	5./S		0.		on		Strain	Are	0 51
Tes oad on	Dial	Moistu Degre	e of Area	onteni satura	Load on Pan	Dial Rdg	5./S		5.		on		Strain	Are	a 67
oad on oan	Dial Rdg	Moistu Degre Strain	Area  cm²  730	onteni saturo Oi- Viii Kamlem	Load on Pan T, Kgm/cm	Dial Rdg	5./S		5.		on		Strain	Are	0 5.
Tes	Dial Rdg 175	Moistu Degre Strain	Area cm² 730 730	onteni saturo Oi- Viii Kamlem	Load on Pan Vi Kgm/cm	Dial Rdg	5./S		5.		on		Strain	Are	a 5.
Tes:	Dial Rdg 175 1.762 1.741 1.72/	Moistu Degre Strain	Area Cm <sup>2</sup> 730 73/	Saturo  Oi-  Viii  Kgm/cm  03  44  85	Load on Pan Vi Kgm/cm -93 1.34	Dial Rdg	5./S		0.		on		Strain	Are	a oī
Tes: .oad on .oan .oan .oan .oan .oan .oan .oan .	Dial Rdg 125 1.762 1.741 1.72/ 1.699	Moistu Degre Strain	Area	01- Viii Kamlem 03 .44 .85 1.26	Lood on Pan 41 Kgm/cm 1.34 1.75 2.16	Dial Rdg	5./S		0.		on		Strain	Are	α στ
Tes:	Dial Rdg 	Moistu Degre Strain	Area	001 e ni Saturo 07	Load on Pan Vi Kgm/cm -93 1.34	Dial Rdg	5./S		0.		on		Strain	Are	α στ
Tes  .oad on -an	Dial Rdg 175 1.762 1.741 1.72/ 1.699 1.677 1.654 1.628	Moistu Degre Strain 	730 730 732 732 733 734	001 en 1 saturo	Load on Pan T1 Kam/cm - 93 1-34 1-75 2-16 2-57 2-98 3-38	Dial Rdg	5./S		5.		on		Strain	Are	0 67
Te: .oad on -an	Dial Rdg 1.75 1.762 1.741 1.699 1.677 1.654 1.628	Moistu Degre Strain 	730 730 730 731 732 732 733 734 735	03 44 85 1.26 1.67 2.98 2.48 2.89	Load on Pan Ti Kam/cm 1.34 1.75 2.16 2.57 2.98 3.38 3.79	Dial Rdg	5./S		0.		on		Strain	Are	0 67
Te:	Dial Rdg 	Moistu Degre Strain 	730 730 731 732 732 733 734 735 736	03 .44 .85 .1.26 .1.67 .2.08 .2.48 .2.99 .3.29	Load on Pan Ti Kam/cm 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19	Dial Rdg	5./S		5.		on		Strain	Are	0 67
Te:	Dial Rdg 	Moistu Degre Strain 	730 730 731 732 732 733 734 735 736 738	03 .44 .85 .1.26 .1.67 .2.08 .2.48 .2.99 .3.69	Load on Pan Ti Kam/cm 134 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59	Dial Rdg	5./S		5.		on		Strain	Are	0 57
Te:	Dial Rdg 175 1.762 1.741 1.677 1.654 1.628 1.597 1.555 1.492 1.390	Moistu Degre Strain 	730 730 731 732 732 733 734 735 736 738	03 .44 .85 .726 .67 .208 .248 .299 .3.29 .3.69 .4.07	Load on Pan   T1   Kam/cm   P3   1.34   1.75   2.16   2.57   2.98   3.38   3.79   4.99   4.97	Dial Rdg	5./S		5.		on		Strain	Are	0 57
Te:	Dial Rdg 1.762 1.762 1.741 1.629 1.647 1.654 1.628 1.555 1.492 1.390	Moistu Degre Strain 	730 730 730 731 732 732 733 734 735 736 738 742 743	03 .44 .85 .7.26	Load on Pan   T1   Kam/cm   P3   1.34   1.75   2.16   2.57   2.98   3.38   3.79   4.99   4.97	Dial Rdg	5./S		5.		on		Strain	Are	a 67
Tes:	Dial Rdg 1.762 1.741 1.699 1.617 1.654 1.628 1.595 1.492 1.340 1.340 1.263 1.135	Moistu Degre Strain 	Cm²  Cm²  730  730  731  732  732  733  734  735  736  742  743  746  750	07- 7:::  (3-44- 85- 1:26- 1:67- 2:08- 2:48- 2:48- 2:48- 2:48- 2:48- 4:07- 4:30- 4:32- 4:43- 4:43-	Lood 90 Pan 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 4.97 5.10 5.22 5.33	Dial Rdg	5./S		5.		on		Strain	Are	a 67
Te:	Dial Rdg 1.762 1.741 1.72/ 1.699 1.677 1.654 1.595 1.595 1.492 1.340 1.263 0.970	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Load of Pan 41 Kgm/cm 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 5.22 5.33 5.43	Dial Rdg	5./S		σ		on		Strain	Are	α στ
Te:	Dial Rdg 1.762 1.741 1.699 1.617 1.654 1.628 1.595 1.492 1.340 1.340 1.263 1.135	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Lood 90 Pan 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 4.97 5.10 5.22 5.33	Dial Rdg	5./S		5.		on		Strain	Are	α στ
Te:	Dial Rdg 1.762 1.741 1.72/ 1.699 1.677 1.654 1.595 1.595 1.492 1.340 1.263 0.970	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Load of Pan 41 Kgm/cm 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 5.22 5.33 5.43	Dial Rdg z	5./5 38 Strain	Arec			on		Strain	Are	α στ
Te:	Dial Rdg 1.762 1.741 1.72/ 1.699 1.677 1.654 1.595 1.595 1.492 1.340 1.263 0.970	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Load of Pan 41 Kgm/cm 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 5.22 5.33 5.43	Dial Rdg z	5./S	Arec			on		Strain	Are	α στ
Te:	Dial Rdg 1.762 1.741 1.72/ 1.699 1.677 1.654 1.595 1.595 1.492 1.340 1.263 0.970	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Load of Pan 41 Kgm/cm 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 5.22 5.33 5.43	Dial Rdg z	5./5 38 Strain	Arec			on		Strain	Are	0 57
Te:	Dial Rdg 1.762 1.741 1.72/ 1.699 1.677 1.654 1.595 1.595 1.492 1.340 1.263 0.970	Moistu Degre Strain 	730 730 732 732 733 734 735 736 738 742 743 746 750	07- 7:11 Kgm/cm 03 .44 .85 1.26 1.67 2.08 2.48 2.89 3.29 4.07 4.30 4.32 4.43 4.53	Load of Pan 41 Kgm/cm 43 1.34 1.75 2.16 2.57 2.98 3.38 3.79 4.19 4.59 5.22 5.33 5.43	Dial Rdg z	5./5 38 Strain	Arec			on		Strain	Are	0 67



UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE \$5 SOIL MECHANICS LABORATORY LOCATION HOLE TRI-AXIAL COMPRESSION DEPTH TECHNICIAN S.U.M. DATE 15/1/59 Machine Data:-Description of Sample:\_ T.O. NATIVE GRAVEL CRUSHED TO 1/2" MAX. Machine No.\_\_\_\_ COMPACTED AT APPROX. 6.5% MOISTURE Multiplication Factor — FELT LINER & CIRC GAUGE USED Wt. Loading Block + Piston (gms.) 21 Kam. SPECIMEN DATA Specimen Number 1 2 3 4 5 6 Lateral Pressure (0Th ) Kgm. /59. cm 0.30 243/4 Length inches 720 Area sq. cms. C.C. S. Cu. ft. Volume 1.600 Ibs/cu.ft. Xd Dry Unit Weight 135.5 Gs= · Volume Soil Solids Zwet 144.2. Wt. Tare + Soil + Water at start Wt. Tare + Soil + Water at end 6879 Wt. Tare + Soil 6514 WET SOLL USED 230.5 165. Number and weight of Tare 821 5693 Wir Soil Weight of water Before Moisture content Test Degree of saturation Weight of water 365 After Moisture content 6.41 Test Degree of saturation 72 oad Load Load Dial Dial Dial Strain Area or Strain Area Strain Area 51 on Oi on o n Rdg Rda Rdg. an Pan Pan AREA VI- VIII DAD DIAL CIRC STRAIN DC V ROG ROG cm2 Kam/cm2 Kam/cm2 115. 115. 0/0 In 5. gm. 0 2.927 39 7/8 720 .03 -33 100 2.918 397/8 720 .17 .47 .04 39 15/16 1/16 .61 2.901 .11 723 200 .31 3915/16 2.872 .22 723 44 .74 300 1/16 39 15/16 .88 200 2.835 .37 1/16 723. .58 1.02 .56 1/8 725 500 2.789 40 .72 2.734 40 /16 .78 3/16 728 .85 1.15 00 .99 1.29 1/4 00 2.669 40 1/8 1.04 730 2.586 401/4 1.38 3/8 735 1.12 1.42 300 1.55 2.497 403/8 1/2 740 1.25 1.74 000 2.369 1.37 1.67 409/16 747 2.26 13/16 1.79 1.49 100 2.194 40 11/16 2.96 752 1.60 200 1.962 40 7/8 765 1.90 3.90 300 1.390 42 6.21 Z 1/8 804 1.64 1.94 400 0.730 433/8 8.88 31/2 861 1.65 1.95 41/2 1.98 500 0.140 44 3/8 11.26 904 1.68 FAILURE BY BULGING

PROJECT



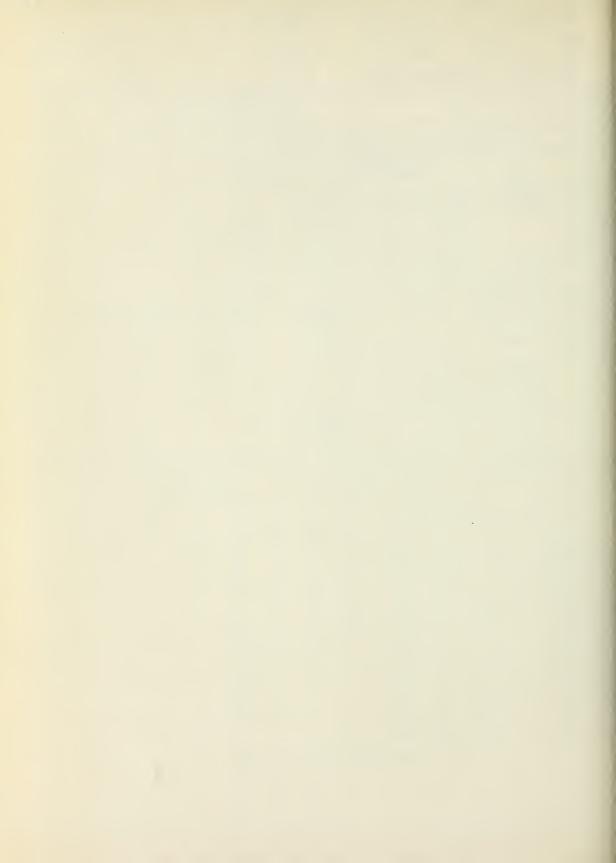
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Mach	ine Da	ta:-						Desc	ripti	0.0	of S	ample:				
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		on Fac										APPR				
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Spec	imen I	Vumber					1	2			3	4	5		6	
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Are				q. cms.			120									
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.oad	Dial				Load						Load	Dial				
on	Dial Rda	Degre Strain			Lead	Dial		Area	57		on	Dial Rda	Strain	Ar	ea	51
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on Pan	Rdg	Strain	Area	67	Lead on Pan	Dial Rdg	Strain	Area	57		on		Strain	Ar	60 (	<i>σ</i> ,
on		Strain		67	Lead on Pan	Dial		Area	67,		on		Strain	Ar	60	σ,
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on Pan Logo	Rdg	Strain	Area	67	Lead on Pan Area	Dial Rdg	Strain		07		on		Strain	Ar	e a (	67
Coao Kan	PIAL ROG	Strain CIRC ROG	Area STRAIN	<b>C</b> τ ΔC	Load on Pan AREA	Dial Rdg. Vi-Viii	Strain  V,  Kym/cm		57		on		Strain	Ar	ea	στ
COAO Kan	Plac Rog 125.	Strain  CIRC  ROG  173.	Area STRAIN	OT AC	Load on Pan AREA Cm²	Dial Rdg Vi-Viii Kym/cm	Strain  Vi  Kym/cm		57		on		Strain	Ar	60 (	στ
00 200 200	Piac Rog 125. 2.986 2.965	Strain  CIRC  ROG  173.  391/8  40	Area Strain %cq	105.	Load on Pan  AREA  Cm²  720 725	Dial Rdg. Vi-Viii Kym/cm .03	Strain  Vi  Kym/cm  -63 -91		57		on		Strain	Ar	60 (	67
0n 200 49n 0 200 100	Plac Rog 173. 2.986 2.965 2.921	Strain  CIRC  ROG  173.  39 1/8  40  40 1/16	### Area    Strain	ΔC //ns //8 3/16	Load on Pan     AREA	Dial Rdg.  777  Kym/cm  .03 .31 .58	Strain  √,  -63 -91 -7.18		67.		on		Strain	Ar	60	σι
00 200 200	Piac Rog 125. 2.986 2.965	Strain  CIRC  ROG  173.  391/8  40	### Area    Strain	105.	Load on Pan     AREA	Dial Rdg. Vi-Viii Kym/cm .03	Strain  Vi  Kym/cm  -63 -91		07.		on		Strain	Ar	е а	στ
0 1000 1000 1000	Play Rog 173. 2.986 2.965 2.921 2.853	Strain  CIRC ROG  172. 397/8 40 40 1/6 40 1/6	### Area    Strain   %	105. 105. 1/8 3/16	Load on Pan	Dial Rdg. ∇7∇111 Kym/cm .03 .31 .58	Strain  √7  √9  √91  1.18  1.45		67.		on		Strain	Ar	е а	01
0 100 100 100 100 300	Place Robert Rob	Strain  CIRC  ROG  102.  3978 40 40 1/6 40 1/6 40 3/6	### Area    STRAIN     %     -	105. //8 3/16 5/16 5/16 5/16	Load on Pan	Dial Rdg. ∇7-√111 Kym/cm · 03 · 31 · 58 · 85 1.12 1.39 1.66	Strain  √7  Kgm/cm  -63 -91  1.18  1.45  1.72  1.99  7.26		57		on		Strain	Ar	60 (	57
0 200 100 300 200 200 200 200 200	Play Rog Pos. 2.986 2.965 2.921 2.853 2.762 2.651 2.526 2.359	Strain  CIRC ROG  1732.  3978 40 40 1/6 40 1/6 40 3/6 40 1/4 40 1/4 40 1/2	### Area    STRAIN     %     -     .   .     .   .     .   .     .   .	7/8 3/16 3/16 5/16 3/8 5/8	Load on Pan	Dial Rdg. ∇7-√1111 .03 .31 .58 .85 1.12 1.39 1.66 1.91	Strain    \(\forall i\)   \(K_gm/cm\)   \(\forall i\)   \(\for		67.		on		Strain	Ar	60	57
0 200 400 300 200 200 200 200 200 200 200	Play Rog Pla	Strain  CIRC ROG  1733.  3978 40 4016 4016 40316 40316 4014 4012 4017 4017	## Area    STRAIN     %     -	7/05.  7/05.  7/05.  7/8  3/16  5/16  5/16  5/16  5/16  13/16	Load on Pan	Dial Rdg  \[ \forall \tau \column{2}{\text{Norm}} \text{Con} \\ \text{Norm} \text{Con} \\ \text{Norm} \text{Con} \\ \text{Norm} \text{Norm} \\ \text{Norm} \text{Norm} \\ \text{Norm} \text{Norm} \\ \text{Norm} \text{Norm} \\ N	Strain    \forall 7,		67		on		Strain	Ar	60	55
0	Professional Profe	Strain  CIRC ROG  1703.  3978 40 40 1/16 40 1/16 40 3/16 40 1/4 40 1/4 40 1/4 40 1/4 40 1/4 41 3/16 41 3/16	### Area    STRAIN     %     -	CT  AC  ////////////////////////////////	Load on Pan	Dial Rdg.  \[ \sqrt{7\sqrt{n}} \]  \[ \langle \frac{\sqrt{n}}{\chi} \]  \[ \langle \frac{\sqrt{n}}{\sqrt{n}} \]  \[ \langle \	Strain  Kym/cm  -63 -91 1-18 1-25 1-99 2-26 2-51 2-76 2-96		67		on		Strain	Ar	60	0
0	Professional Profe	Strain  CIRC  ROG  1733.  3978  40 /16  40 /16  40 /16  40 /16  40 /1  40 /1  40 /1  40 /1  40 /1  40 /1  40 /1  41 /1  41 /1	### Area    Strain     9%     -	CT  //S  //B  3/16  3/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16	Load on Pan	Dial Rdg.  \$\forall 7 \forall 7  \$\langle 2.36 \\ 2.45 \\  \text{Dial} \\ \text{Rdg.} \\  \text{Vi}	Strain  Kym/cm  -63 -91 1-18 1-45 1-72 1-99 2-26 2-51 2-76 2-96 3-05		67		on		Strain	Ar	60	σί
0	Professional Profe	Strain  CIRC ROG  1703.  3978 40 40 1/16 40 1/16 40 3/16 40 1/4 40 1/4 40 1/4 40 1/4 40 1/4 41 3/16 41 3/16	### Area    Strain     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 15/16 15/16 15/16 2	Load on Pan	Dial Rdg.  \[ \sqrt{7\sqrt{n}} \]  \[ \langle \frac{\sqrt{n}}{\chi} \]  \[ \langle \frac{\sqrt{n}}{\sqrt{n}} \]  \[ \langle \	Strain  Kym/cm  -63 -91 1-18 1-25 1-99 2-26 2-51 2-76 2-96		67,		on		Strain	Ar	60	07
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/4 40 1/4 40 1/4 40 1/4 41 3/16 41 1/3 41 1/8	## Area    Strain     9%     -     .09     .27     .54     .134     .188     2.15     3.49     4.65     5.52     6.68	CT  //S  //B  3/16  3/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16  5/16	Load on Pan	Dial Rdg.  \$\forall 7\forall 7  \times \forall 3.31  \cdot 88  \cdot 85  \ldot 1.12  \ldot 1.39  \ldot (.91)  \times 1.16  \times 2.36  \times 2.45  \times 2.53	Strain  -63 -91 -1.18 -1.45 -1.72 -1.94 -2.51 -2.76 -2.96 -3.05 -3.13		67,		on		Strain	Arr	60	07
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/6 40 1/1 40 1/1 40 1/1 41 1/1 41 1/1 41 1/8 43	## Area    STRAIN     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 13/16 15/16	Load on Pan	Dial Rdg. √7√ .03 .31 .58 .85 1.12 1.39 1.66 1.91 2.16 2.36 2.45 2.53 2.51 2.49	Strain				on		Strain	Ar	60	07
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/6 40 1/1 40 1/1 40 1/1 41 1/1 41 1/1 41 1/8 43	## Area    STRAIN     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 13/16 15/16	Load on Pan	Dial Rdg. √7√ .03 .31 .58 .85 1.12 1.39 1.66 1.91 2.16 2.36 2.45 2.53 2.51 2.49	Strain				on		Strain	Ar	60	07
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/6 40 1/1 40 1/1 40 1/1 41 1/1 41 1/1 41 1/8 43	## Area    STRAIN     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 13/16 15/16	Load on Pan	Dial Rdg. √7√ .03 .31 .58 .85 1.12 1.39 1.66 1.91 2.16 2.36 2.45 2.53 2.51 2.49	Strain				on		Strain	Ar	e a .	57
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/6 40 1/1 40 1/1 40 1/1 41 1/1 41 1/1 41 1/8 43	## Area    STRAIN     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 13/16 15/16	Load on Pan	Dial Rdg. √7√ .03 .31 .58 .85 1.12 1.39 1.66 1.91 2.16 2.36 2.45 2.53 2.51 2.49	Strain				on		Strain	Ar	e a .	07
0	Place Robert Rob	Strain  CIRC ROG  103.  3978 40 40 1/6 40 1/6 40 3/6 40 1/6 40 1/1 40 1/1 40 1/1 41 1/1 41 1/1 41 1/8 43	## Area    STRAIN     9%     -	CT  AC  1/05.  //8 3/16 5/16 5/16 5/16 13/16 15/16	Load on Pan	Dial Rdg. √7√ .03 .31 .58 .85 1.12 1.39 1.66 1.91 2.16 2.36 2.45 2.53 2.51 2.49	Strain				on		Strain	Ar	e a .	07



	UNIVE	RSIT	Yo	f Al	LBER	RTA		PROJ	ECT					
	DEP T							SAME	1.5	46		1.1	20	The second
								LOCA			VGER	17 -	MIRTUR	E 5
	SOIL						1						DEDTI	
	TRI-A	XIAL	CC	)MPF	RESS	NOI		HOLE	NICI	ΛN	80	il	DEPTH DATE 15	11/50
Mash	ina D-	t a :		***************************************										7,37
Mach	ine Da ine No	10:-	7	7				Des	Cripi	101	01 5	ample:	D TO 1%	" 111
	plicatio					100		Com,	DACT	E	2 97	APPROX	GAUGE	DISTURE
W1. Lo	ading	Block	+ Pist	on (gm	IS.)	/ Agm.		FE	T	_/~	ER &	LIRC.	GAUSE	USED
					SPECI	MEN			DA	ГА				
Spec	imen l	Number	r				- 1		2		3	4	5	6
Late	ral P	ressur	e (	57x ) K	90/39	.cm.	0.90							
Leng	th		iı	nches			241/4	L						
Are	a		s	q. cms.			720							
Volu	me			.C. S.	cu. ft	4.	1.567							
	Unit W						136.8							
Gs=	۰۷٥	olume	Soil	Solids	8 we	=+	145.7							
	Tare +									W	ET SO	IL USEC	228	165.
	Tare +						573	/						
Wt.	Tare +	Soil					5424	-						
-	ber an		ght of	Tare			616							
	Soil						4808							
Befo		Weigh	t of v	vater						T				
	- 1	Moist			1									
Tes	57	Degre						1						
Aft	0.5	Weigh					307			1				
		Moistu			·		6.39							
Tes	51			saturo		%	75							
							<del></del>			-	Lond			
oad on Pan	Dial Rdg	Strain	Area	01	Load on Pan	Dial Rda	Strain	Are	0		Load	Dial Rdg	Strain A	rea 57
1 4.1	3				1 611	, , , , , , , , , , , , , , , , , , ,		1	+	-	7 011	-		
COAD	DIAL	CIRC.	STRAIN	AC	AREA	VI - VIII	42						1	
	ROG	ROG												
							1		<del></del>		ļ			
Kam.	175.	1115.	%	105.	Cm2	Kgm/cm2	Kym/ch	27	-					
0	2.965	397/8			720	-03	.93	-	+					
300	2.936	39 15/16		1/16	723	.44	1.34	1	-					
	2.864		.42		725									
200	2.761	40 1/16	.84	3/16	728	1.27	2.17		-					
200	2.640	40 1/8		1/4	1 730	1.67	2.57	1					<u> </u>	
500	2.410	40 5/16		7/16	737	2.06	1 2.96				1		-	
1800	2.245	40 1/2		5/8 1	745	2.45	3.35	-						
3300	1.930	407/B		15/16	759	3.01	3.91		-					
2400		41 3/8		11/2	779	3.12	1 4.02							
	1.500	4113/11		1 15/16		3.29	4.19		1					
1	1.290	42 1/16	6.91	23/16	807	3.37	4.27							
	0.990	421/2	1	25/8	825	3.54	-	i				1		
1/00	0.000	44 1/8	12.23	4 1/4	893	3.49	4.39		-					
	<u> </u>	<b>+</b>				FAIL	IRE BY	V Bu	GING				1	
		-				1 ///20		1502	1	-i-umo				
							-	-	-		ļ			
		ž.			1		1	1	1					



PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE #6 SOIL MECHANICS LABORATORY LOCATION HOLE DEPTH TRI-AXIAL COMPRESSION TECHNICIAN B. a. IL DATE 27/1/59 Machine Data:-Description of Sample:\_ NATIVE GRAVEL CRUSHED TO I" MAX Machine No.\_\_ Aultiplication Factor\_ COMPACTED AT OPT. MOIST. CONTENT EELT LINER USED Vt. Loading Block + Piston (gms.) 21 Kgm SPECIMEN DATA Specimen Number 1 3 4 5 2 6 Lateral Pressure (07%) Kam/sq.cm 0.30 Length inches 24 1/2 720 Area sq. cms. C-0:5: Cu. ft. 1.581 Volume Dry Unit Weight | Ibs/cu-ft. 8d 124.5 Gs= · Volume Soil Solids & wet 131.0 Wt. Tare + Soil + Water at start 8249 Wt. Tare + Soil + Water at end WET SOIL USED 207 16s. 7887 Wt. Tare + Soil Number and weight of Tare 856 7031 Wt. Soil Weight of water Before Moisture content Test Degree of saturation Weight of water 362 After Moisture content 5.15 Test Degree of saturation 40 oad Logd Load Dial Dial Dial Strain Area 5. on Strain Area 01 cn Strain Area or Rdg. Rda Rdg. Pan Pan , an VIII T, cm2 Kgm/cm Kam/cm2 ins Sam 0 2.968 720 .33 .03 .47 00 2.958 .01 721 .17 .61 2.952 .02 721 .31 200 .74 2.942 721 44 300 .03 2.928 .58 .88 200 .04 722 500 2.915 .72 1.02 .05 722 2.900 .07 722 .86 1.16 200 723 1.00 700 2.884 .08 1.30 2.867 .10 723 1.14 1.44 300 2.848 1.27 1.57 200 112 724 1.41 1.71 2.824 .14 725 000 2.791 726 1.54 1.84 .18 100 200 2.737 727 1.68 1.98 300 2.643 .32 1.81 2.11 730 1.93 2.23 400 2.400 .57 738 1.95 450 1.880 1.09 754 2.25 FAILURE BY BULGING



PROJECT UNIVERSITY of ALBERTA SITE DEP T. of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE#6 SOIL MECHANICS LABORATORY LOCATION HOLE DEPTH TRI-AXIAL COMPRESSION TECHNICIAN B. J. M. DATE 27/1/59 Machine Data:-Description of Sample: NATIVE GRAVEL CRUSHED TO I" MAX lachine No.\_\_\_\_ COMPACTED AT OPT. M.C. fultiplication Factor\_ It. Loading Block + Piston (gms.) 21 Kgm FELT LINER USED SPECIMEN DATA 1 3 4 Specimen Number 2 5 6 Lateral Pressure (07%) Kam. /54 0.60 inches 243/8 Length Area sq. cms. 720 Volume C.C-S- cu.ft 1.573 Dry Unit Weight lbs/cu.ft. 8d 129.8 Gs= · Volume Soil Solids &wet 136.6 WET SOIL USED 215 166 Wt. Tare + Soil + Water at start 9455 Wt. Tare + Soil + Water at end 9033 Wt. Tare + Soil 919 Number and weight of Tare 8114 Wt. Soil Weight of water Before Moisture content Test Degree of saturation 422 Weight of water After 5.20 Moisture content Test Degree of saturation % 47 boc Load Loud Dial Dial Dial Strain Area Strain Area 5. Strain Area 57 01on Pan Rda Rdq Rdg. Pan an V.111 VI cm2 Kamlom Kamlon ins gn 2.947 720 .63 0 .03 2.938 720 .31 .91 .04 200 721 200 2.920 .// .58 1.18 722 .19 2.900 .86 1.46 00 100 2.880 .28 722 1.14 1.74 200 2.859 1.41 136 723 2.01 1.69 .46 724 2.29 200 2.834 200 2.804 .59 725 1.96 2.56 ,00 2.762 .76 726 2.23 2.83 300 2.695 1.03 728 2.50 3.10 2.76 732 3.36 000 2.573 1.53 3.00 200 2.278 741 2.74 3.60 300 1.810 4.66 756 3.07 3.67 305 1.610. 5.48 762 3.04 3.64 FAILURE BY BULGING



PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE#6 SOIL MECHANICS LABORATORY LOCATION TRI-AXIAL COMPRESSION HOLE DEPTH TECHNICIAN Bul. DATE 27/1/59 Machine Data:-Description of Sample: NATIVE GRAVEL CRUSHED TO I" MAX. Machine No.\_\_ Multiplication Factor\_ COMPACTED AT OPT. M.C. FELT LINER USED Wt. Loading Block + Piston (ams) 21 Kam SPECIMEN DATA Specimen Number - 1 5 2 3 4 6 Lateral Pressure (07%) Kgm/59. cm 0.90 Length inches 24/2 720 Area sq. cms. C-C-S. Cu.ft. Volume 1.581 Dry Unit Weight Ibs/cu.ft. 2d 125.2 Gs= · Volume Soil Solids Swet 131.9 Wt. Tare + Soil + Water at start Wt. Tare + Soil + Water at end 7420 WET SOIL USED 208.5 165 Wt. Tare + Soil 7091 Number and weight of Tare 833 Wt. Soil 6258 Weight of water Before Moisture content Test Degree of saturation Weight of water 329 After 5.25 Moisture content Test Degree of saturation oad. Load Load Dial Dial Dial Strain Area 6 Strain Area Strain Area 57 on 01on Pan on Pan Pan Rdg Rdg Rdg. Vill 7. cm2 Kgm/cm Kgm/cm2 0/0 ins. gm 0 2.925 720 .03 .93 1.21 2.919 02 721 31 200 2.908 07 721 .58 1.48 100 1.76 200 2.895 .12 721 .86 722 2.881 .18 1.14 2.04 300 2.866 .24 722 1.41 2.31 000 2.59 200 2.848 723 1.69 .31 400 2.823 723 2.86 .42 1.96 600 2.790 .55 724 2.24 3.14 3.41 800 2.745 .74 726 2.51 3.67 1000 2.652 1.11 729 2.77 2200 2.500 1.74 733 3.03 3.93 742 :400 2.200 2.96 3.26 4.16 2600 1.710 4.96 758 3.46 4.36 700 1.310 6.59 771 3.53 1800 0.740 8.92 791 3.57 1 4.47 840 0.540 798 3.58 4.48 9.74 FAILURE BY BULGING



PROJECT UNIVERSITY of ALBERTA SITE DEP T. of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE #6 SOIL MECHANICS LABORATORY LOCATION HOLE DEPTH TRI-AXIAL COMPRESSION TECHNICIAN B.C. H DATE 27/1/59 Machine Data:-Description of Sample: NATIVE GRAVEL CRUSHED TO 1" MAX Machine No.\_\_\_\_ COMPACTEU ABOVE OFT. M.C. Multiplication Factor\_ FELT LINER & CIRC GAUGE USED Nt. Loading Block + Piston (ams.) 21 Kgm SPECIMEN DATA Specimen Number 1 2 3 5 6 (074 ) Bam/ sq.cm Lateral Pressure 0.30 Length 245/8 inches Area sa. cms. 720 e.c.s. cu. ft. Volume. 1.591 Dry Unit Weight Ibs/cu.ft. 8d 137.6 Gs= · Volume Soil Solids 8 wet 146.4 Wt. Tare + Soil + Water at start WET SOIL USED = 233 165. Wt. Tare + Soil + Water at end 7096 6710 Wt. Tore + Soil Number and weight of Tare 801 Wt. Soil 5909 Weight of water Before Moisture content Test Degree of saturation Weight of water 386 After 6.53 Moisture content Test Degree of saturation 79 oad. Load Load Dial Dial Dial Strain Area Strain Area IStrain Areal Oi On OB on Pan Rd d Rda Rdq Pan Pan STRAL AREA VI-VIII DIAL CIRC 4 C OAD RDG ROG cm2 Kgm/cm2 Kgm/cm2 105. 105. 0/6 igm. 175 39 29/32 0 2.968 720 03 .33 47 2.959 11 -720 .17 100 .04 2.930 .61 200 .15 720 .31 2.880 39 15/16 .36 1/32 722 .45 - 15 300 400 2.825 40 .58 3/32 724 .58 .88 727 5/32 1.02 2.764 40/16 183 .72 500 600 7/32 2.701 401/B 1.08 729 .85 1.15 40 3/16 1.37 9/32 731 99 1.29 700 2.630 11/32 734 1.42 12.552 1.69 1.12 401/4 800 2.475 403/8 2.00 15/32 739 1.25 1.55 200 19/32 000 1 2.376 2.40 743 1.37 1.67 401/2 2.267 405/81 2.85 23/32 748 1.50 1.80 100 200 2.145 140 13/16 3.34 29/32 756 1.62 1.92 1.965 411/8 4.07 17/32 768 1.72 2.02 300 123/32 400 1.685 41 5/8 5.21 788 1.80 2.10 2.15 1.85 219/32 500 1.210 421/2 7.14 822 3 31/32 1600 0.520 43 1/8 9.94 881 1.84 2.14 5 5/32 1.83 2.13 1685 0.000 451/16 12.05 932 BY BULGING FAILURE



PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE WINGER PIT - MIXTURE #6 SOIL MECHANICS LABORATORY LOCATION HOLE TRI-AXIAL COMPRESSION DEPTH TECHNICIAN IS a sil DATE 27/1/59 Machine Data:-Description of Sample: NATIVE GRAVEL CRUSHED TO 1" Machine No.\_\_ MAX. COMPACTED ABOVE OPT MC Multiplication Factor\_ FELT LINER & CIRC GAUGE USED Wt. Loading Block + Piston (gms) 21 Kam SPECIMEN DATA Specimen Number - 1 2 5 6 Lateral Pressure (07h) Kgm./59.cm. 0.60 Length inches 24 5/8 sq. cms. 720 Area Volume \_C. C.S. Cu. ft. 1.591 Dry Unit Weight lbs/cu.ft. Xd 135.7 Gs= · Volume Soil Solids 144.5 Wt. Tare + Soil + Water at start WET SOIL USED = 230 1165. Wt. Tare + Soil + Water at end 8515 Wt. Tare + Soil 8054 Number and weight of Tare 926 Wt. Soil 7128 Weight of water Before Moisture content Test Degree of saturation 461 Weight of water After Moisture content 6.48 Test Degree of saturation % 73 oad Load Load Dial Dial Dial Strain Area G. Strain Area or Strain Area on OT on Pan on Pan Rdq Rdg Rdg OAD DIAL CIRC. STRAIN DC AREA VI - VIII ROG ROG cm2 Kam/cm2 Kam/cm Kam. 175. 115. 39 7/8 0 2.942 720 .03 63 ~ .91 200 2.905 .15 720 .31 2.830 .46 720 .58 1.18 400 600 2.735 .84 720 .86 1.46 1.73 2.622 40 1/8 725 1.13 800 1.30 1000 2.493 40 1/16 1.82 3/16 728 1.40 2.00 403/16 2.44 5/16 732 1.67 2.27 2.342 1200 1/2 2.184 40 3/8 740 1.92 2.52 1400 3.08 1.976 40 5/8 3.92 3/4 750 2.16 2.76 1600 1.655 800 403/41 5.23 7/8 755 2.41 3.01 413/8 7.48 11/2 767 2.64 3.24 3000 1.100 421/4 8.74 0.790 2 3/8 815 2.60 3.20 2100 2.63 3.23 0.403 10.31 846 43 % 3 3/4 3.26 0.010 11.91 872 2.66 2300 3.28 43 3/4 11.95 0.000 3 7/8 877 2.68 FAILURE BY BULGING



1	DEP T. SOIL	of C MECHA XIAL	NICS	ENG	INEE	RING		LOCAT	E W	_		Pir -				
Machi	ine Da	ta:-						Desci	riptic	o n	of S	ample:				
Machi	ne No							NATIV	E GA	2 1	IVEL	CRUSH.	ED TO	1"	M	AX
Aultip	olicatio	on Fac	tor					COM	PAC	Z	ED A	BOVE	OPT	M	<u> </u>	
Vt. Lo	ading	Block -	+ Pisto	on (gm	s.)	1 Kgm	5.	FELT	411	15	RE	CIRC.	GAU	GE	Us	ED
				9	SPECI	MEN			DATA	Δ						
Spec	imen f	Number					1	2		_	3	4	5			6
		ressur		7x ) K	am /59.	cm.	0.90									
				ches	1		24 1/4									
Arec				q. cms.			720									
Volu	m e		_C.	0.5.	cu.ft		1.567									
	Unit W	eight	11	s/cu.f	1. 88		139.0									
		olume				9 †	148.0									
		Soil +														
		Soil +	Water	at	end		7922			W.	ET SO	IL USE	q = 23	32	165	
	are +						7489									
		d weig	tht of	Tare			182						-			!
W†-	Soil						6707							-		
Befo	re	Weigh											-	_		
Tes	†	Moistu											<del> </del>			
		Degre			tion			-								
Aft	er	Weight					433						+			
Tes	st	Moistu				%	6.46						-	-		
		Degra	e or :	salura	11011	70	83	1								
oad on Pan	Dial Rdg	Strain	Area	07	Load on Pan	Dial Rdg.	Strain	Area	51		Load on Pan	Dial Rdg.	Strain	Are	e a	51
OAD	DIAL	Cies	STRAIN	00	AREA	Y T	7	-		-						
UNU	ROG	ROG	UTRAIN	20	AREA	11-411						,				
Kam	175.	175.	%	105	cm2	Kgm/cm2	Kamlon	4							-	
0	2.970	40 3/16	_		720	.03	.93			-					-	
-	2.873	"	.40	-	720	.31	1.21									
400	2.690	401/4	1.16	1/16	723	.58	1.45									
800		40 3/8	Contract of the last of the la	3/16	728	.85	1.75	1								
1000	2.112		3.54	5/16	735	1.12	2.02								-	
1200	1.900	40 7/8	4.41	11/16	750	1,63	2.53									
400	11675	413/16	5.34		759	1.87	2.77								-	
1600			6.49	1 3/8	774	2.09	3.20	7					-		-	
2000		42 1/2	7.88	25/16	792	2.30	3.39	-(			,				-	
2200	0.282	431/4		31/16	843	2.63	3.53									
2380	0.040	43 5/8	12.08	37/16	859	2.80	3.70								-	
1420	0.000	43 15/16	12.25	3 3/4	872	2.80	3.70								-	
		+			FAI	LURE	BY	BULG	ING							
	-	-						-		-						
										1						

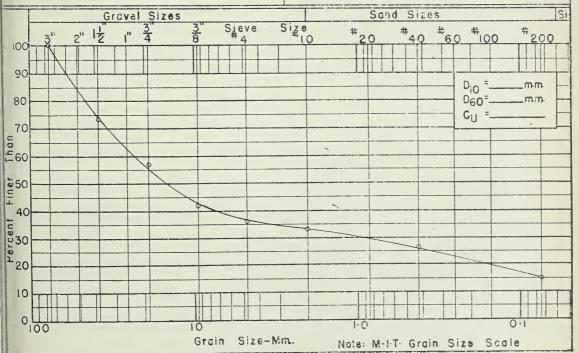


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SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

PROJECT
SITE
SAMPLE WINGER MIXTURE \* 1 RETER
LOCATION TRIAXIAL TESTS.
HOLE DEPTH

		Total V		TECHNI	CIAH BU	-SC DATE	9/2/59
Total Dry Weight of Sample 18,476	Sieve No.	Size of (		Weight Retained gms.	Total Wi. Finer Than gms.	Percent Finer Thon	% Finer Than Basis Orig.
Initial Dry Weight Retained No. 4		3"					
Tare No Wt. Dry + Tare		11/2"		4903	18 476		13
Tare		3/ <sub>4</sub> 3/ <sub>8</sub>	19·10 9·52	3030	7890		57 4-2
Wt. Dry	4	·185	4.76	2653 1115	6775		36.1
Passing	4						
Initial Dry Weight Passing No. 4	10	·079	2.000	489	6286		33.4
Tare No:	20	.0331	.840	107	8200		
Wt Dry + Tare	40	·0165	·420 ·250	1329	4957		26.2
Tare	100	·0059	149				
Passing	200	.0029	.074	2187	2770		15.0
Possing	200		l	L	J		

Time of Sieving





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DEP'T of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

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PROJECT
SITE
SAMPLE WINGER MIXTURE #2 AFTER
LOCATION TRIAXIAL TESTS
HOLE , DEPTH
TECHNICIAN B.a. L DATE 10/2/59

Note: M-1-T- Grain Size Scale

				1	(31/410 / 2.01		
otal Dry Weight	Sieve	Size of C		Weight Retained gins.	Total W1. Finer Than gms.	Percent Finer Than	% Finer Than Ecsis Orig.
f Sample 23,370	No.	Inches	Mm.	gins.	g ms.		sample"
nitial Dry Weight etained No. 4						•	
are No.		3"		_	23,370		100
/t. Dry + Tare		1 1/2"		5,642	17,728		76
are		3/4	19.10	4,379	13,349		57
Vt. Dry		3/8	9.52	2,598	10,751		46
	4	⋅185	4.76	2,599	8.152		34.9
Passing	4						
nitial Dry Weight							
assing No. 4	10	.079	2.000	2,160	6992		29.9
are No	20	.0331	·840				
Vt. Dry + Tare	40	.0165	.420	1,876	5116		21.9
Tare	60	.0097	·250				
Vt. Dry	100	.0059	.149				
	200	.0029	.074	2,454	2662		11.4
Passing	200				]		

Description of Sample \_\_\_\_\_ Method of Preparation \_\_\_\_\_\_ Remarks \_\_\_\_\_

Grain Size-Mm.



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SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

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0100

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Grain Size-Mm.

PROJECT
SITE
SAMPLE WINGER MIXTURE #3 AFICE
LOCATION TRIAMAL TESTS
HOLE DEPTH

JIL V L	PAIA	ALI		TECHNI	CIAN 15 a	IL DATE	11/2/59		
Total Dry Weight	Sieve	Size of (	)pening			Percent Finer Than			
of Sample 27,150	No.	Inches	Mm.	Weight Retained gms.	Total Wt. Finer Than gms.	riner Inan	% Finer Than Basis Orig.		
Initial Dry Weight									
Retained No. 4									
Tare No.		3"			27158		100		
Wt Dry + Tare		11/2"		6330	20828		7.1		
Tare		3/4	19.10	5037	15791		58		
Wt. Dry		3/8	9.52	4103	11688		43		
	4	·185	4.76	2734	8954		33		
Passing	4								
nitial Dry Weight									
Passing No. 4	10	.079	2.000	1353	7601	İ	28		
Tare No-	20	.0331	.840						
Wt. Dry + Tare	40	.0165	.420	2/55	5446		20		
Tare	60	.0097	·250						
Wt. Dry	100	.0059	149		Ì				
W1. D1)	200	.0029	.074	2954	2492		9.2		
Passing	200								
Time of Sieving				IVE III G F A S _					
	el Sizes			Sand Sizes Si					
11	3"	3" S	ieve S						
3" 2" 12 1	" <del>3</del>	3" S	# 4	*10	20 #40	#60 #100	#2,00		
100									
90			444						
						D <sub>10</sub> =-	m_		
80							m.m.		
						CU =-			
70					1				
E 60									
-60	8								
250									
950									
40		-							
C		-							
030			-						
0									
1 20									
20									

Note: M·I·T· Grain Size Scale

1.0



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SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

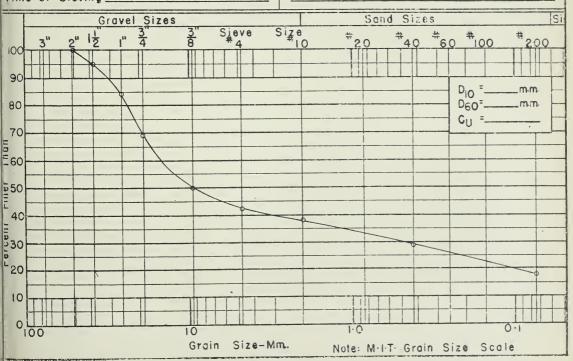
PROJECT
SITE
SAMPLE WINGER MIXTURE #4 AFTER
LOCATION TRIAXIAL TESTS.
HOLE DEPTH
TECHNICIAN A 2L DATE 12/2/59

					211111	The second secon	
otal Dry Weight of Sample 19,937	Sieve No.	Size of (		Weight Retained gms.	Total Wt. Finer Than gms.	Percent Finer Thon	% Finer Than Basis Orig Sumple
nitial Dry Weight		3 .					
etained No. 4		2		-	19,937		100
are No		11/2		935	19.002		95
/t. Dry + Tore		1		2230	16772		84
are		3/4	~19.10	2938	13,834		69
/t. Dry		3/8	9.52	3813	10,021		50
	4	⋅185	4.76	1678	8343		42
Passing	4						
nitial Dry Weight							
assing No. 4	10	.079	2.000	783	7560		38
are No	20	.0331	.840				
Nt. Dry + Tare	40	.0165	.420	1696	5864		29
Tare	60	.0097	-250				
Nt. Dry	100	.0059	.149				
	200	.0029	.074	2286	3578		17.3
Danning	200						

Passing 200

Description of Sample \_\_\_\_\_\_ Method of Preparation \_\_\_\_\_\_

Remarks \_\_\_\_\_\_





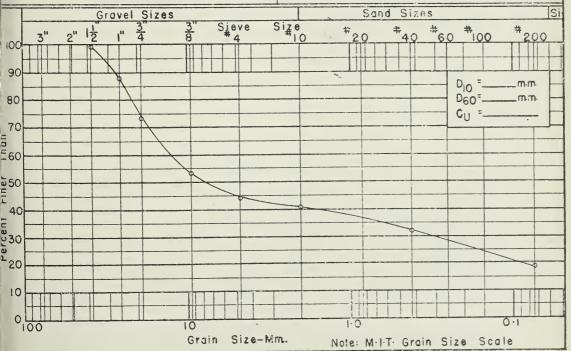
UNIVERSITY of ALBERTA DEP'T. of CIVIL ENGINEERING SOIL MECHANICS LABORATORY SIEVE ANALYSIS

200

PROJECT SITE SAMPLE WINGER MIXTURE # 5 FROM LOCATION TRIAXIAL TESTS DEPTH HOLE

				TECHNI	CIANA	M. DAIL	13/2/59
otal Dry Weight	Sieve	Size of (		Weight	Total Wt. Finer Than ams.	Percent Finer Thon	% Finer Than
Sample 22,665	No.	Inches	Mm.	gms.	g ms.		Easis Orig.
itial Dry Weight		3					
etained No. 4		2			22 665		100
are No		11/2		305	22,360		99
t. Dry + Tare		1		2350	20,010		88
are		3/4	19.10	3479	16.531		73
it. Dry		3/8	9.52	4416	12.115		53
	4	⋅185	4.76	2052	10,063		44
Passing	4						
nitial Dry Weight							j.
assing No. 4	10	.079	2.000	826	9,237		41
gre No	20	.0331	-840				
Vt. Dry + Tare	40	.0165	.420	2022	7,215		32
are	60	∙0097	·250				
Vt. Dry	100	.0059	1149			<u></u>	
	200	.0029	.074	3023	4,192		18.5

Passing Method of Preparation Description of Sample\_ Remarks. Time of Sieving.





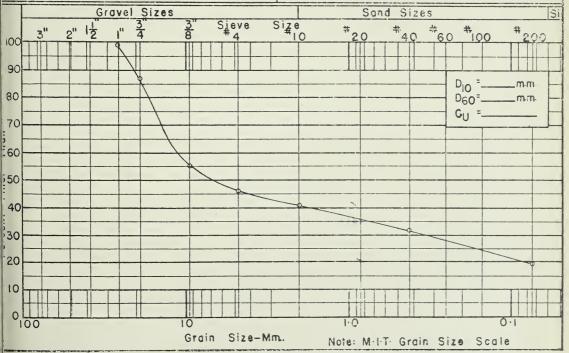
UNIVERSITY of ALBERTA
DEP'T of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

PROJECT
SITE
SAMPLE WINGER MINTURE #6 AFTER
LOCATION TRIAXIAL TESTS.
HOLE DEPTH
TECHNICIAN DATE

Sieve	Size of	Opening	Weight	Total_W1.	Percent	% Finer Than
No.	Inches	Mm.	gms.	gms.	Finer Inon	% Finer Than Basis Orig.
	11/2		-	15,785		100
	- 1		155	15,630		99
	3/4	19.10	1936	13,694		87
	3/8	9.52	4959	8,735		55
4	⋅185	4.76	1530	7.205		46
4						
10	.079	2.000	734	6471		41
20	.0331	.840				
40	.0165	.420	1400	5071		32
60	∙0097	.250				
100	.0059	.149				
200	.0029	.074	2052	3019		19.1
200						
	4 4 20 40 60 100 200	No. Inches  1 1/2  1 3/4  3/8  4 .185  4  10 .079  20 .0331  40 .0165  60 .0097  100 .0059  200 .0029	No. Inches Mm.  1'/\(\gamma\)  1 \(\frac{1}{\gamma}\)  1 \(\frac{3}{\gamma}\)  1 \(\frac{3}{\gamma}\)  3 \(\frac{9}{3}\)  4 \(\frac{185}{4}\)  4 \(\frac{185}{4}\)  10 \(\cdot 0.79\) 20 \(\cdot 0.331\) 40 \(\cdot 0.165\) 40 \(\cdot 0.165\) 60 \(\cdot 0.097\) 200 \(\cdot 0.059\) 100 \(\cdot 0.059\) 200 \(\cdot 0.029\) 200 \(\cdot 0.029\)	No. Inches Mm. Retained gms.  11/2  1 155  3/4 19·10 1936  3/8 9·52 4959  4 ·185 4·76 1530  10 ·079 2·000 734  20 ·0331 ·840  40 ·0165 ·420 1400  60 ·0097 ·250  100 ·0059 ·149  200 ·0029 ·074 2052	11/2 - 15.785  1 155 15,630  3/4 19·10 1936 13.694  3/8 9·52 4959 8,735  4 ·185 4·76 1530 7,205  4 10 ·079 2·000 734 6471  20 ·0331 ·840  40 ·0165 ·420 1400 5071  60 ·0097 ·250  100 ·0059 ·149  200 ·0029 ·074 2052 3019	11/2 - 15.785  1 155 15,630  3/4 19·10 1936 13.694  3/8 9·52 4959 8,735  4 ·185 4·76 1530 7,205  4 10 ·079 2·000 734 6471  20 ·0331 ·840  40 ·0165 ·420 1400 5071  60 ·0097 ·250  100 ·0059 ·149  200 ·0029 ·074 2052 3019

Description of Sample \_\_\_\_\_\_ Method of Preparation \_\_\_\_\_\_ Remarks \_\_\_\_

Time of Sieving





APPENDIX C

DETAILED TEST DATA FOR PART B



PROJECT UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE CRANFORD - #40 SOIL MECHANICS LABORATORY LOCATION ADLITIVE DEPTH LIMITS HOLE ATTERBERG TECHNICIAN M. J. M. DATE 28/10/58 Liquid Limit rial No. 2 o. of Blows 38 41 33 11.5 11 10 ontainer No. V26 125 V24 123 A13 A15 t. Sample Wet + Tare 106.99 121.47 119.11 11.3.57 10171 10911 't Sample Dry + Tare 97.85 111.53 107.93 92.26 96.74 93.63 It. Water 9.14 9.44 11.18 4.94 7.51 12.37 are Container 73.50 8486 71.88 69.34 69.01 60.64 tof Dry Soil 24.35 26.61 30.05 24.29 23.25 30.10 oisture Content w% 37.5 37.3 37.2 40.9 40.4 71.1 Plastic Limit Average Values Trial No. / Wi= 38.5 Container No. AH BE AE wp= 20.3 Wt. Sample Wet+Tare 57.7774 61.7673 60 7505 Wt. Sample Dry + Tare | 56.7438 | 60.5328 | 54.6392 ws = \_\_\_\_ Wi- Water 0.9836 1.2345 1.3113 Ip = 18.2 Tare Container 52.0623 54.3916 53.0899 If = \_\_\_\_ Wt of Dry Soil 4.7315 6.1412 6.5493 41 Moisture Content 20.8 20.1 20.0 I+ =\_\_\_\_ Shrinkage Limit Trial No. HContainer No. Wt Sample Wet + Tare 40 Wt Sample Dry + Tare Wt Water Hare Container Wt of Dry Scil W. Moisture Content w% 39 Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-V. Shrinkage Limit We W = W ( V-Vo x 100) 38 Description of Sample: 37 Remarks: SAMPLE SOAKED FOR 5 HOURS BEFORE TESTING 36 7 8 9 10 20 25 30 Number of Blows



UNIVERSITY of ALBERTA	SITE
DEP'T of CIVIL ENGINEERING	SAMPLE CRAWFORD - + + + = 0.5%
SOIL MECHANICS LABORATORY	LOCATION NORMAL FORTLAND
ATTERBERG LIMITS	HOLE DEPTH
ATTENDENO LIIVITTS	TECHNICIAN MILLIONS DATE 16/12/58
Liquid Limit	•
rial No.	
o. of Blows	
ontainer No.	
It Sample Wet + Tare	
/t· Sample Dry + Tare	
/t· Water	
are Container	
It of Dry Soil	
oisture Content w%	
Average Values	Plastic Limit
Average values	Trial No. 1 2 3
w <sub>1</sub> =	Trial No. / 2 3 Container No. $BA \notin BG$ AT $BK$
wp= 21.9	Wt. Sample Wet+Tare 61.0514 61.6263 62.5749
w <sub>s</sub> =	Wt. Sample Dry + Tare 59.5220 60.2519 60.7811
	Wt. Water 1.5294 1.3744 1.7938
1 <sub>p</sub> =	Tare Container   52.2528 53.7176 53.2661
I <sub>f</sub> =	Wt. of Dry Soil 7.2692 6.5343 7.5150
I <sub>1</sub> =	Moisture Content % 21.0 21.0 23.8
	Shrinkage Limit
	Trial No.
المراز المراز والمراز	Container No.
	Wt. Sample Wet + Tare
	Wt Sample Dry + Tare
	Wt. Water
	Tare Container Wt of Dry Soil Wo
	Moisture Content 40%
	Vol. Container V
	Vol. Dry Soil Pat Vo
	Shrinkage Vol. V-Vo
	Shrinkage Limit Ws
	$w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$
	Description of Sample:
	Remarks: CURING TIME 1 HOUR.
7 8 9 10 15 20 25 30 40 Number of Blows	
Minnet of Diowa	



	UN	IIVEF	RSI	TY		of		ALE	BE	RT	A		SITE				
	DE	P'T	of	CI	VI	1	FI	NGIN	F	FRIN	JG.			65.01	- 0 0	# !	1 . 0.
														CRAWA			
		L M											LOUATI	ON	140%	DEDTH	OKILAND
	A	TTE	R	3E	K	G		L	M		5		TECHNI	CIAN MIL	1-/ANS	DATE	117/58
-								lia		d 1	imit		1.2011111	OTAIT ////	2010143	071272	772750
ia	I No-				7			Liq	1	u L	_ 1 111111	1			1		
_	of Blo	) III C			-				-			-					
	lainer				-				-			-			-		
_	Sampl	-	4.7						$\vdash$			-					
_					-				$\vdash$			-					
_	Samp! Nater		7 1	are	-				-			-					
-					-				-			-					
	of Dr				-				-			-					
	sture			1 24	0/				-			-					
01:	Ture	1 1	en	<u> </u>	701			T	1			1					
					-			Aver	aa	e Ve	alues	-		Plastic			
								1				Tr	ial No.	, No-	/	2	3
		-	+	+	-							Co	ntainer	No.	BW	AH	BE
						H		w	,= - = d	24.	.7	Wt	Sample	Wet+Tore	63.7442	59.8052	63 2512
					-			12.5	=			WT	· Sample	Ury + lare	61.9110	58.2541	61.5091
					+							W	- Water		1.7732	1.5511	1.7421
					+							To	re Cont	ainer	54.7360	52.0623	54.3916
					1		-	4				Wt	of Dry	Soil	7.2350	6.1918	7.1175
					+			TA	=			Mo	isture C	ontent %	24.6	25.1	24.5
		+		+	$\pm$			-1	•					Shrinkage	Limit		
			-	$\dashv$	+		++	1	111	ППТ	<del>11111111</del>	Tri	ial No.				
					T	H						Co	ntainer	No.			
					-		H					Wt	Sample	Wet + Tare			
					1									Dry + Tare			
					1							Wt	Water				
?					1				Ш				re Cont	ainer			
														Soil Wo			
					+	H						1		ntent w%			
-					-									ner V			
5		1		$\Box$	-									il Pat Vo			
,		1	H		-				-			Sh	rinkage \	Vol. V-V.			
		11	H		1		#		#			Sh	rinkage l	Limit 20%			<u> </u>
			Ħ		1		#		#					()	V - Va	100	
			1		#		#		#			Щ	Ws	= w (-	Wo X II	رەن	
5					1		#		#			Ш					
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	二		##		1				#			F	Remarks:	CURING	TIME	1 Ho	UR
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					-		#					-					
	7 0	9 10			15		20	25		30	40	-					
	1 0			bei			E	Blow:			-10						
		- 11		_ •								1					



UNIVERSITY of ALBERTA	PROJECT					
DEP'T of CIVIL ENGINEERING	SITE					
SOIL MECHANICS LABORATORY	SAMPLE CRAWFORD - #40 & 1.5% LOCATION NORMAL FORTHAND					
ATTERBERG LIMITS						
ATTENDERS LIMITS	TECHNICIAN K. J. M. DATE 16/12/50					
Liquid Limit						
rial No.						
o. of Blows						
ontainer No.						
t Sample Wet + Tare						
t Sample Dry + Tare						
t-Water						
are Container						
tof Dry Soil oisture Content w%						
Average Values	Plastic Limit  Trial No.					
20.5	Trial No. / 2 3 Container No. AD. AV BL AE					
2/ 1	Wt. Sample Wet+Tare 61. 4344 63.1737 61.3267					
<i>w</i> <sub>p</sub> = <u>∠6.4</u>	Wt. Sample Dry + Tare 59.8350 61.3889 59.596/					
$w_p = 26.4$ $w_s = $	WI Sumply Time 57.0330 67.3807 57.3767					
1 <sub>p</sub> =	Wt. Water     1.5994     1.7848     1.7306       Tare Container     53.6548     54.7430     53.0899					
I <sub>f</sub> =	Wt of Dry Soil 6:1802 6.6459 6.5062					
	Moisture Content % 25.8 26.8 26.6					
It =	Shrinkage Limit					
	Trial No.					
	Container No.					
	Wt-Sample Wet + Tare					
	Wt Sample Dry + Tare					
	Wt. Water					
	Tare Container					
	Wt of Dry Soil Wo					
	Moisture Content 45%					
	Vol. Container V					
	Vol. Dry Soil Pat Vo					
	Shrinkage Vol. V-Vo					
	$w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$					
	Description of Sample:					
	Description of Sample					
	Remarks: CURING TIME 1 HOUR					
7 8 9 10 15 20 25 30 40						
Number of Blows						



PROJECT UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE CHAMFORD - #40 & 20% SOIL MECHANICS LABORATORY LOCATION NORMAL PORTUAND DEPTH HOLE ATTERBERG LIMITS TECHNICIAN Su al DATE 31 0158 Liquid Limit rial No. 2 o. of Blows 26 14 32 33 25 17 ontainer No. A15 V24 V26 U25 H13 V23 It Sample Wet + Tare 100.13 92.97 109.10 101.24 104 47 96.53 1. Sample Dry + Tare 91.17 85.34 100.01 93.21 105.47 88.03 It. Water 8.96 7.63 9.00 8.50 9.09 8.03 are Container 69.34 66.64 6901 77.88 73.50 84.86 It of Dry Soil 21.83 22.13 19.71 20.61 19.02 18.70 loisture Content w% 43.7 41.0 40.8 41.1 40.7 46 4 Plastic Limit Average Values Trial No. 2 / w;= 42.0 Container No. AE BE AH Wp= 28.5 Wt. Sample Wet+Tare 59.3346 60.6141 60.3824 Wt. Sample Dry + Tare 57.9624 59.2184 58.5425 Ws = \_\_\_\_ 46 1.8399 Wf. Water 1.3722 1.3957 1<sub>p</sub> = 14.5 Tare Container 53.0899 54.3916 52.0623 If \* \_\_\_\_ Wt of Dry Soil 4.8725 4.8168 6.4802 Moisture Content % 28.2 28.9 28.4 It =\_\_\_\_ Shrinkage Limit 45 Trial No. Container No. Wt Sample Dry + Tare Wt-Water Tare Container 44 Wt. of Dry Soil Wo Moisture Content w% Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-V. 43 Shrinkage Limit We Ws = w ( V-Vo x 100) Description of Sample:\_\_ 42 Remarks: CURING TIME I HOUR 41 7 8 9 10 20 15 Number of Blows



UNIVERSITY	of ALE	BERTA	PROJEC	T			
DEP'T of CIV			SITE				2 6
SOIL MECHANIC			LOCATI	CRAWE			20% O
ATTERBER			HOLE	VII		DEPTH	CILAUD
ATTENDEN	lo Li	11411 1 3	TECHNI	CIAN H			1/10,58
	Liq	uid Limit					
al No.	/	2	3	-1	5		6
of Blows	15	4.5	9.5	28	29		28
ntainer No.	V74	<i>U72</i>	V+4	146	V-71		V.+2
Sample Wet + Tare	102.05	104.12	103.34	127.57	109.		108.21
· Sample Dry + Tare · Water	92.50	93.21	93.24	115.53	99		47.20
re Container	9.55	10.91	10.10	12.04	10.		11.01
of Dry Soil	21.43	23.24	71.56 21.68	31.84	72.		27.38
isture Content w%		46.9	46.6	37.8	37.		36.9
		1		Plastic			30.7
	Aver	age Values	Trial No.	1 / 4 5 1 1 6	/	2	3
	w.		Container	No.	AT	BL	AN
		- H	Wt. Sample				
1/		=	Wt. Sample				
16		10.2	Wt. Water		1.1927		1.2241
			Tare Cont				51.9204
	If		Wt of Dry				1.3460
	I <sub>t</sub>	=	Moisture C		28.3	28.9	128.2
				Shrinkage	Limit		1
14			Trial No.				
		1 <b>- 3 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4</b>	Container				
			Wt-Sample \\ Wt-Sample				
	AHHHH	T	Wt Water	31 y 1 101 C			
42		THE RESERVE OF THE PROPERTY OF THE PERSON OF	Tare Cont	giner			
		1 (   1   1   1   1   1   1   1   1   1	Wt. of Dry S				
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 2 1	Moisture Co				
			Vol. Contai	ner V			
		<del></del>	Vol. Dry So				
40			Shrinkage \				
			Shrinkage l	imit we			
			2.0	= w (Y	-Vo x 10	(00	
			ws		Wo		
			Danasiakia	6 C	nla.		
38			Descriptio	n of Sam	pre:		
		9					
			Remarks:	CURING	TIME	6 Ho	425.
36							
7 8 9 10 15							
Number	of Blows						



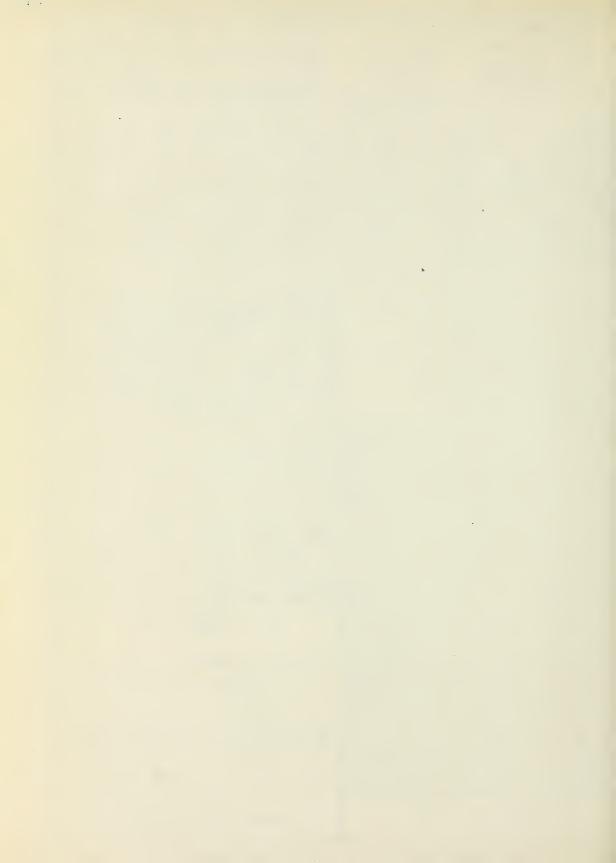
UNIVERSITY of	f ALB	ERTA	PROJECT SITE						
DEP'T of CIVIL	ENGIN	FERING		SAMPLE CARWECKU #45 & 200					
SOIL MECHANICS				ON /					
	LI		HOLE			DEPTH			
ATTENDENO	L- 1	1411 1 3	TECHNI	CIAN A.a	sl	DATE	111158		
	Liq	uid Limit							
rial No.	/	2	3	4	5		í.		
o. of Blows	15	17	19	22	27		27		
	142	V41	V49	V12	V1-	1.	V4L		
	79.63.	109.88	108.66	08.66 106.29			121.33		
	77.23	98.44	97.87	96.00	79.3		110 90		
	12.40	10.94	10.79	10.29	10.9		10.43		
	67.38	72.41	71.56	69.97	71.0		83.69		
	29.85	26.53	26.31	26.03	38.				
Joist die Comem 60 /6	77.3	7/13	47.0	39.5		0 1	30.4		
	Aver	age Values		Plastic		2	3		
	W.	= 38.8	Trial No. Container		AN	BK			
			Wt. Sample						
	W <sub>p</sub>	= 29.3	Wt. Sample						
		3	Wt. Water						
	Ip	= 9.5	Tare Cont						
	14 I4	*	Wt of Dry	Soil	6.3699	4.313	3 5.3976		
	1 1 1 1 1	=	Moisture C	ontent %	29.1	29.2	29.7		
				Shrinkage	Limit				
42			Trial No.						
			Container						
			Wt Sample						
			Wt Sample	Dry + lare			-		
2			Wt-Water Tare Container						
41	+++++++		Wt. of Dry				-		
			Moisture Co						
2			Vol. Contai						
5			Vol. Dry So						
			Shrinkage '						
40			Shrinkage	Limit Wg					
			$w_{s}$	= w (Y	<u>-∨∘</u> x 10	(00			
39			Description	on of Sam	ple:				
		<b>•</b>							
38		<b>\</b>	Remarks:	CURING	TIME	26 H	lours		
7 8 9 10 15	20 25		1						
	Blows	3							



UNIVERSITY of ALBERTA PROJECT SITE DEP'T of CIVIL ENGINEERING SAMPLE CRAWFURD - #40 & 20% SOIL MECHANICS LABORATORY LOCATION VORMAL FORILAND ATTERBERG HOLE LIMITS DEPTH TECHNICIAN A DATE 7/11, 58 Liquid Limit Trial No. No. of Blows 25 12 31 11 35 Container No. V24 V26 V25 V42 V41 V72 Nt. Sample Wet + Tare 116.17 109.85 118.14 105.62 104.37 114.66 Nt. Sample Dry + Tare 105.26 99.49 108.22 94.25 9400 74.96 Mt. Water 10.91 10.36 9.92 11.37 10.37 9.70 fare Container 77.88 73.50 84.86 67.38 72.41 69.97 Vt. of Dry Soil 27.38 25.99 23.36 26.87 26.59 24.99 Moisture Content w% 39.8 39.9 42.5 42.3 39.0 38.8 Plastic Limit Average Values Trial No. w= 39.9 Container No-AT BE wp= 30.1 W1. Sample Wet+Tare 63.9010 61.7211 Wt. Sample Dry+Tare 61.5295 60.0363 w<sub>5</sub> = \_\_\_\_ Wt. Water 2.3715 1.6848 In = 9.8 Tare Container 53.7176 54.3916 Wt of Dry Soil 7.8119 5.6447 43 Moisture Contant % 30.4 29.8 Shrinkage Limit Trial No. Container No. Wt. Sample Wet + Tare 12 Wt. Sample Dry + Tare Wt-Water Hare Container Wt of Dry Soil W. Moisture Content w% -41 Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-V. Shrinkage Limit Ws Ws = w ( V-Vo x 100) ,40 Description of Sample: 39 Remarks: CURING TIME 168 HOURS. 7 8 9 10 15 20 25 30 Number of Blows



PROJECT UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE CRANFORD - # + 7 7 20 SOIL MECHANICS NORMAL PORTLAND LABORATORY LOCATION DEPTH ATTERBERG LIMITS TECHNICIAN B.a. 31 DATE 28, 11, 58 Liquid Limit rial No. 2 o. of Blows 29 9.5 31 32 ontainer No. V71 V46 V23 U24 V49 V26 't. Sample Wet + Tare 110.33 114.74 104 85 104.21 114.09 100.55 't Sample Dry + Tare 99.60 104.63 99.66 93.65 103.16 96.00 t. Water 10.73 10.93 10.55 10.11 10.19 10.56 are Container 69.34 72.41 83.69 73.50 77.88 71.56 't of Dry Soil 24.31 25.28 24.44 27.19 25.94 26.16 oisture Content w% 39.5 39.0 39.0 43.4 43.2 43.2 Plastic Limit Average Values 3 Trial No. 2 W;= 40.0 Container No. BE AN BK Wp= 29.4 Wt. Sample Wet+Tare 58.8657 65.2346 63.7941 Wt. Sample Dry + Tare 57. 6474 62.7678 61.0466 ws = \_\_\_\_ Wt-Water 1.2183 2.4668 2.1475 In = 10.6 Tare Container 53.2661 54.3916 51.9204 Wt of Dry Soil 4.3813 8.3762 9.1262 4 = \_\_\_\_ Moisture Content % 27.8 29.4 30.1 Shrinkage Limit 43 Trial No. Container No. Wt. Sample Wet + Tare Wt. Sample Dry + Tare Wt-Water Tare Container 42 Wt. of Dry Scil W. Moisture Content 40% Vol. Container V Vol. Dry Soil Pat Vo Shrinkage Vol. V-V. Shrinkage Limit Ws Ws = w ( V-Vo x 100) Description of Sample: 40 Remarks: CURING TIME 680 HOURS 39 7 8 9 10 20 15 Number of Blows



UNIVERSITY of	ALBERTA	PROJECT					
DEP'T of CIVIL EN	NGINEERING	SITE SAMPLE ZAWFORD - #40 \$ 2.5%					
SOIL MECHANICS		LOCATION					
ATTERBERG		HOLE TECHNICIAN &	DEPTH				
ATTEMBERO		TECHNICIAN 5	1. of DATE /	7 12/58			
	Liquid Limit						
ial No.							
of Blows							
t Sample Wet + Tare							
t Sample Dry + Tare							
t Water							
re Container			1				
tof Dry Soil							
oisture Content w%							
	A	Plastic	Limit				
				3			
	w <sub>1</sub> = Co	ial No. ntainer No.	BA-86 BK	BE			
		· Sample Wet+Tare					
	w=	· Sample Dry+Tare					
	H I I I I I I I I I I I I I I I I I I I	Water	2.0168 2.1191	2.0386			
	i II	re Container of Dry Soil					
	10.0	pisture Content %					
	I <sub>†</sub> =	Shrinkage		27.0			
	Tributani Tri	ial No.					
		ntainer No.					
		Sample Wet + Tare					
		Sample Dry +Tare					
,		Water					
		re Container					
	: 1 : 1 <b>:</b> 1 <b>:</b> 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1 : 1	of Dry Soil Wo					
		isture Content 45%  1. Container V					
		1. Dry Soil Pat Vo					
·		rinkage Vol· V-Vo					
		rinkage Limit We					
		CV	/-Va				
		ws = w (Y	W. x 100)				
	D	escription of Sam	ple:				
		Remarks: CURING	TIME 1 HOW	R			
7 8 9 10 15 20							
Number of E	Blows _						



UNIVERSITY of	ALE	BERTA	PROJEC	Ι			
DEP'T of CIVIL E	NGIN	FERING	SITE		-71	4 .4	- 0
SOIL MECHANICS				CRAWFO			
			LOCATI	ON N	CRINAL	DEDTH	AND
ATTERBERG	L	MITS	TECHNI	CIANKU	7/	DATE	111/50
	1:0	uid Limit		0.417) 51	7	DAILS	111/32
rial No.							
		2	3	4			6
o. of Blows		35	36	7	9		9
ontainer No. U2.		A13	126	A15	V2.		V24
t Sample Wet + Tare //7.		103.16	109.35	100.67	117-		14 62
t. Sample Dry + Tare 105.		94.66	100.42	90.70	107.		03.92
t. Water //.		8.50	8.93	9.97			10.70
are Container 69. tof Dry Soil 35.		69.01	73.50	66.64			77.88
	-	25.65	26.92	24.06			26.04
oisture Content w% 33	.2	33.1	33.2	41.5	1 41.	2	41.0
	Aver	age Values		Plastic	Limit		
	11		Trial No.			2	3
	11	= 35.4	Container		AT	AH	AE
	w	b= 29.1	Wt. Sample				
	wa	2	Wt. Sample				
	11	= 6.3	Wt. Water		2.0055	1.8031	1.7319
	7		Tare Cont				53.0899
43	4	*	Wt of Dry				5.7734
	I <sub>t</sub>	=	Moisture Co			29.0	30.0
	# ·			Shrinkage	Limit		
			Trial No.				
			Container				
41			Wt Sample				
			Wt Sample [	Dry + Tare			
			Wt Water				
			Tare Cont				
		f + + 1       + +	Wt. of Dry S				
39			Moisture Co				
			Vol. Contain				
			Vol. Dry Soi				
			Shrinkage \				
			Shrinkage L				
			2.0	= w (Y	-Vo x 10	(00	
37			-3		Wo		
	MIII		Descriptio	n of Sam	pie:		
35							
			Pomerks.	CURING	7	1 1/2	7
			Kemurks:	CURING	INIE	1 70	U.K.
7 8 9 10 15 20		30 40					
	) 25 Blows	30 40					
110111001 01							



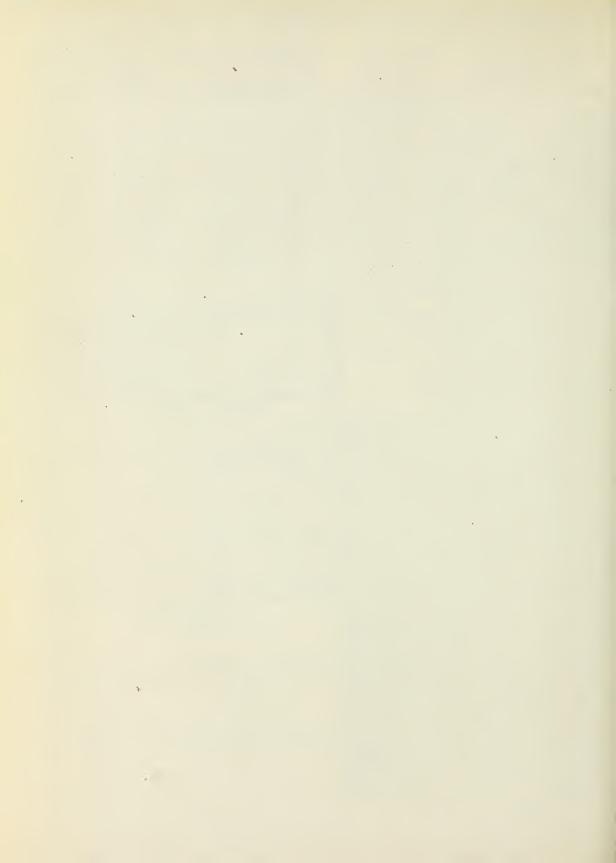
UNIVERSITY of ALBERTA PROJECT									
DEP'T of CIV	IL ENGIN	IEERING	SAMPLE CRAWFORD - #40 \$ 50%						
SOIL MECHANIC	S LABO	RATORY		ON					
ATTERBER	G	STIME							
ATTENDEN	G L	IIVIII 5	TECHNI	CIANK	11.	DATE 3	111 58		
	Lic	quid Limit							
Trial No.	/	2	3	4	5		6		
No. of Blows	9	10	7	34	41		34		
Container No.	V46	U74	V42	V41	U4	4	V12		
Wt. Sample Wet + Tare	125.56	116.38	104.88	115.05	109		03-95		
Wt Sample Dry + Tare	112.65	102.49	93.39	102.44			94.34		
Wt· Water	12.91	13.89	11.49	12.06			756		
Tare Container	83.69	71.07	67.38	72.41		56 69.97			
Wt of Dry Soil	28.96	31.42	26.01	30.58		16 24.42			
Moisture Content w%	44.6	44.2	44.2	39.4		5	39.2		
	Avar	age Values		Plastic	Limit				
	+++++		Trial No.		/	2	3		
	w	= 40.7	Container	Nο·	BE	BK	AN		
	w	p= <u>33./</u>	Wt Sample	Wet+Tare	61.4784	61.8221	60.0098		
		=	Wt Sample	Dry + Tare	59.7814	59.6855	57.9381		
		7/	Wf. Water						
	Ip.	= 7.6.	Tare Cont	ainer	54.3916	53.2661	519204		
	4	=	Wt. of Dry	Soil	5.3898	6.4194	6.0177		
	I.	=	Moisture Co	ontent %	31.5	33.3	34.4		
				Shrinkage	Limit				
46			Trial No.						
			Container I						
			Wt. Sample						
			Wt Sample D	ry + Tare					
844			Wt-Water						
44			Tare Cont						
=			Wt of Dry S Moisture Co						
000000000000000000000000000000000000000			Vol. Contain						
6			Vol. Dry Soi						
			Shrinkage V						
42			Shrinkage L						
2				CV	- V				
Moistu			2/8	= w (Y	<del>- v°</del> x 10	00)			
0									
			Descriptio	n of Sam	ple:				
40									
		<b>A</b> 10							
			5		-	/ //			
38			Remarks:_	CURING	IME	6 Ho	URS.		
30									
7 0 0 10	20 05	30 40							
7 8 9 10 15 Number	of Blows								
144									



DEP'T of CIV		SAMPLE CRAWFORD - # +0 & 5.0 %					
SOIL MECHANICS LABORATORY			LOCATION NORMAL PORTLAND				
ATTERBER	TECHNICIAN B. d DATE 4/11/58						
Liquid Limit							
rial No.		2	3	4	5		'n
o of Blows	41	39	38	7	9		26
ontainer No.	V46	V74	V49	V+1	12	4	V42
It Sample Wet + Tare	130.83	109.15	104.41	110.26	113.	62 1	105.41
Vt. Sample Dry + Tare	117.38	98.69	99.03	98.39	102		94 49
Vt. Water	13.45	10.46	10.38	11.87			10.92
are Container	83.69	71.07	71.56	72.41		.88	6738
Vt. of Dry Soil Noisture Content w%	33.69	27.62	27.47	25.98		2.55	21.11
Tolsture Content W%	37. 9	37.9	37.8 45.7			45.6 40.	
	Aver	age Values		Plastic			
		= 40.2	Trial No.		7	2	3
			Container		AN	8K	AE
		P	Wt. Sample				
	Ws	=	Wt. Water				1.9761
	10	= 7.5	Tare Cont				
		8	Wt. of Dry	Soil	5,/337	6.0941	5.8912
47			Moisture C	ontent %	32.4	32.3	33.5
	11	3	Shrinkage Limit				
			Trial No.				
1			Container	No.			
			Wt-Sample				
45			Wt-Sample Dry + Tare				
2			Wt. Water				
			Tare Cont				
			Wt. of Dry Soil Wo				
5,,			Moisture Content w%				
43			Vol. Container V				-
3			Vol· Dry Soil Pat Vo Shrinkage Vol· V-Vo				
		= 40 (	Shrinkage				
							-
41			$w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$ Description of Sample:				
39							
	Remarks: CURING TIME 36 HOURS.						
37	1						
7 8 9 10 15 Number							
Number of Blows							
			M				

ALBERTA

UNIVERSITY of



UNIVERSITY	of ALE	BERTA	PROJEC	T			
DEP'T of CIV			SITE				
				CRANF			
SOIL MECHANIC	LABO	RAIDRY	HOLE	A NC			
ATTERBER	G L	IMITS	TECHNI	CIANO	nt.	DATE	11/11/58
	Lic	quid Limit		7/			
Trial No.	/	2	3	4	5		7.
No. of Blows	21	23	/3	10	2 5		30
Container No.	V23	V41	1/25	A13	Vat		V46
Nt. Sample Wet + Tare	104.40	103.79	118.12	9900	108.		111.87
Wt. Sample Dry + Tare	93.48	94.17	107 58	B4 37	97		103.52
Wt. Water	10.92	7.02	10.54	9.63	11		8.35
Tare Container	69.34	72.41	84.86	6901		56	8369
Nt of Dry Soil	24.64	21.76	22.72	20.36	25	.57	19.83
Moisture Content w%	44.3	44.2	46.4	47.3	43	./	42.1
	Aver	age Values		Plastic	Limit		
	<del>+++++</del>	-	Trial No.		/	2	3
	1 1 1 1 1 1	1= 43.1	Container			AT	BK
	w	p= <u>34.1</u>	Wt. Sample				
47		=	Wt. Sample				
	1	= 9.0	Wt Water		1.5131	2.006	2.1583
			Tare Cont	coil	52.0623	53.7776	53.2661
	<del></del>	*	Wt of Dry Moisture Co	ntent %	21.5	33.9	1
	I+	=	1	Shrinkage		33.7	34.2
46	<del>                                      </del>		Trial No.	Sirriikuge	L111111		1
			Container	No.			
			Wt Sample				
			Wt Sample E				
			Wt. Water				
3845			Tare Conte	ainer			
			Wt of Dry S				
			Moisture Co				
			Vol. Contain				
3	111/4		Vol. Dry Soi				-
44			Shrinkage V Shrinkage L				
e							1
DI SION			W <sub>s</sub>	= w (Y	-V <sub>0</sub> x 10	00)	
43		2	Descriptio	n of Sam	ple:		
			Remarks:	CURING	TIME	196 H	OURS.
42							
7 8 9 10 15 Number	of Blows	30 40					
Mamper	OI DIOWS						



UNIVERSITY of ALE	BERTA	PROJEC	Τ			
DEP'T of CIVIL ENGIN		SITE	CRAWFO	2.6	D* ,	- 02
SOIL MECHANICS LABO		SAMPLE	ON	Non	4 5	1 27 0.0
		HOLE		1400	DEPTH	CKILAND
ATTERBERG L	IIVIII 5	TECHNI	CIAN K.a	M	DATE	2 58
Lic	uid Limit					
Trial No.	2	3	4	5		6
No. of Blows 37	38	38	7	10		8.5
Container No. V25	V 72	A15	V74	AI.		42
Wt. Sample Wet + Tare 126.81	104.23	104.40	104.62	107.	76 10	5.81
Wt Sample Dry + Tare 113.96	93 73	92.88	93.38			73.02
Wt. Water 12.85	10.50	11.52	11.24		96	12.19
Tare Container 84.86	69.97	66 64	71-07	64.	01	67.38
Wt. of Dry Soil 29.10	23.76	26.24	22.31	25	.79	25.64
Moisture Content w% 44.2	44.2	43.9	50.4	50	.3	49.9
Ave	rage Values		Plastic L	imit		
		Trial No.		/	2	3
	1= 45.8	Container		AH	AT	AE
w	p= <u>39.1</u>	Wt. Sample				
24	=	Wt. Sample				
	= 6.7	Wf. Water				2.8464
		Tare Cont				
I <sub>f</sub>	=	Wt. of Dry				7.2530
I.	=	Moisture C			34.3	34.2
			Shrinkage	Limit		1
		Trial No.				
		Container				
		Wt Sample Wt Sample				
		Wt. Water	Dry ridie			
3 50		Tare Cont	giner			
50 0		Wt. of Dry				
=		Moisture Co				
o o o o o o o o o o o o o o o o o o o		Vol. Contai				
0		Vol. Dry So				
		Shrinkage '				
40		Shrinkage 1	Limit Wg			1
2		2.0	= w (Y	-Vo x 10	Coc	
DISTO SE DIN		Ws	- 00 (0)	No.		
ο <del>Σ</del>				-1-		
46		Description	on of Sam	pie:		
		Remarks:	CURING	TIME	678	HOURS
44	1					
7 8 9 10 15 20 2	5 30 40	1				
Number of Blow						



UNIVERSITY	of ALP	FRTA	PROJEC	T			
DEP'T of CIVI			SITE				
			SAMPLE	CRAWF	DA'D - #	40 5 4	1.5%
SOIL MECHANIC			LOCATI	ON	NORT	DEDTH	TLAND
ATTERBER	G LI	MIIS	TECHNI	CIAN S.d	Millione	DATE	1/2/58
	lia	uid Limit					
rial No.					T		
o. of Blows					1		
ontainer No.							
It Sample Wet + Tare							
/t· Sample Dry + Tare							
/t· Water							
are Container							
It of Dry Soil							
loisture Content w%							
		age Values		Plastic	Limit		
		age Values				Z	3
		=	Trial No. Container	No.	BW	HE	BL
	w	29.1	Wt. Sample	Wet+Tare	65.9070	61.6643	63.8387
	2.5	-	Wt. Sample				
	<del></del>		Wt. Water		2.5480	1.4353	2 0087
	<sup>1</sup> p		Tare Cont				
	I <sub>f</sub>		Wt of Dry				
	I.	-	Moisture C			29.2	28.4
				Shrinkage	Limit		
			Trial No.				
			Container				
			Wt Sample				
			Wt Sample	Dry + lare			
8			Wt-Water			<del></del>	
			Tare Cont				
			Wt. of Dry Moisture Co				
v l			Vol. Contai				
			Vol. Dry So				
			Shrinkage				
			Shrinkage				
<u> </u>				(1)	1-V		
			Ws	= w (-	W. X 10	(00	
			Description	on of San	nple:		
			Remarks:	CURINO	A TIME	1 HO	ik
			1				
7 8 9 10 15							
Number	OI DIOW:						



UNIVERSITY of ALE	BERTA	PRO				
DEP'T of CIVIL ENGIN	FERING	SITE	PLE CRAW	FARA	A 10 6	0 - 0
SOIL MECHANICS LABO			ATION			
ATTERBERG L		HOL	E		DEPTH	1-100
	IIVII I O	TECI	HNICIAN 5	1. H-	DATE 5	/11/58
Lic	quid Limit					
Trial No.	2	3	4	5	-	6
No. of Blows 3/	34	37	15	16		16
Container No. V26	V23	V72	A13	V25		A15
Wt. Sample Wet + Tare 116.07	108.70	112.97	112.19	123.	72 10	07.84
Wt. Sample Dry + Tare 105.19	98.76	102.11	100.25	113.	05	76.58
Wt. Water 10.88	9.44	10.86		10.		11.26
Tare Container 73.50 Wt. of Dry Soil 31.69	69.34	69.97		84.		66.64
	29.42	32.14		28.		29 94
Moisture Content w% 34.3	33.8	338	38.2	37.	9	37.6
Aver	age Values		Plastic	Limit		
		Trial N		/	2	3
	35.6	Contain		AT	AH	BE
w	$p = \frac{\chi 9.0}{}$		ple Wet+Tare			64.0663
W <sub>s</sub>	p= 29.0		ple Dry+Tare			
	/ /	W? Work	e r	1.8709	2.1378	2.2307
			ontainer			
			ry Soil Content %			
It	=	WOISTUTE			20.5	30.0
		Trial No	Shrinkage	LIMIT		1
		Containe				-
			le Wet + Tare			
			le Dry + Tare			
		W1-Wate				
38			ontainer			
			y Soil Wo			
5			Content w%			
38		Vol. Con				
9			Soil Pet Vo			
			e Vol. V-Vo			
•		Shrinkag	e Limit Ws			
36 5			ws = w ()	<u>√-V∘</u> x 10	(00	
5 E		Descrip	otion of Sam	ple:		
34						
					. 17	-
		Remark	s: CURINO	IIME	1 70	DUR
<b>7 8 9 10</b> 15 20 25	30 40					1
Number of Blows						



		U	INI	VE	ER	S	T	Y		of		1	ALE	3E	R	T	Д			PROJE(	CT						
		D	EF	r'T	. 0	f	C	IV	11		E	N	GIN	IEI	ER	RIN	G		100	SAMPL	FC	RAWE	aP.	D - *	20	É s	3.0%
													ABO							LOCAT							
													L							HOLE TECHN							
								- 1	-	_			-	114	-					TECHN	IICIA	NAC	1 1	1.	DAT	E 5	/11/58
													Lic	ui	d	L	imi	t									
ric	1	No	٥.						T		/	,		T		2		T		3		4.	T	5			6
10.	of	8	101	H S							29	?				36				38		13		1.7			26
10	nto	iin	er	No	).					L	14	2			V	14	6		L	149		V 41		V2.	4.		V74
۷t٠	S	ı m	ple	W	et	+ .	Tar	е		10	5.	8	7		118	g.,	39		10	5.89		04.46		112.0	9	/	06.46
Vt.	Sc	m	ple	D	ry	+	Tar	е		9	5.	4	76		109	7.	12		9	6.72		95 18		102.	27		96.80
Nt-	W	af	er						L		0.	9	21		9	9.	27			9.17		7.28		9.1			9.66
			on						L				88				69	1		71.56		72.41	_	77.	88		71.07
			) r y						+				08				43	4		25.16		22.77		24			25.73
10	ist	ur	е	Co	nt	en	tu	50/6	1	1-1	37		/			36.	4			36.5		40.8		40	. 3		37.6
	-		-				_				+	1	Avei	raa	8	Vσ	lues	,			PI	astic					
	-		-			-		1	-		11	н						Щ		al No.				/	_ ~		3
	-	_							-	$\exists$		$\parallel$	W					- 14		ntainer				9E	8		AN
	ŀ						_		$\pm$		$\perp$	╣	w	p= .		30	.0										62.0141
	-								1	$\pm 1$		$\mathbb{H}$	wo	=				- 11									59.6587
	-									H		$\prod$					.9	- U	W t	Water			/	.7248	2.0	580	2.3554
,	F		-	-				$\blacksquare$	+	-		-						- H	Tar	e Con	tain	er	53	1.0899	53.2	2661	51.9204
4	4		I <sub>f</sub> *																								7 7383
	-																		MO			10000			29.	8	30.4
	-		I+ =																		Shr	Inkage		ımıt			
	F																	1111		al No	41 -		-				
	F																	1111		Samula			-				
4	0																			Sample Sample							
	-																	ши		Water		1 1010					
%	F																	111F		re Con		er					
	-		-				-	H	+	1	-	+						1117		of Dry							
ב								$\mathbb{H}$			$\forall$	$\pm$								isture C							
Te	39						-				1	$\pm$						Ш	Vol	. Conta	iner	V					
Conter			-	-				$\mathbb{H}$	-	$\mathbb{H}$		4		1						· Dry S							
												A								inkage							
								H					MI					Ш	Shr	inkage							, , , , ,
STUL	38	_										+								2u	/s = ·	w ()	/-V	<u>/</u> x 10	(00		
MOI																			D	escripti	i o <b>n</b>	of San	ple	e:			
															\ \ \ \ \				_								
1	37			-								+			1												
				-			+	-	+	+		-							R	emarks	: <u>C</u>	URING	7	IME	6	Ho	PURS
			F	F						+		-					9										
			1	-				-	H									+	-								
	36		F	F					H	+									-								
1		7	8	9 1					5	_		0	2		30		40		-								
					N	u n	n b e	r		o f		В	low	S					-								



UNIVERSITY	of ALE	BERTA	PROJEC	Τ			
DEP'T of CIVI	I FNGIN	FERING	SITE	(0015	-00	0 1 - 2	0 4:
SOIL MECHANIC				CRAWF			
ATTERBER	G	MAITC	HOLE		/	DEPTH	
ATTENDEN	G LI	IMILI	TECHNI	CIAN M. Ca	il	DATE 6	111/58
	Liq	uid Limit					
Trial No.	/	2	3	4	5		6
No. of Blows	24	25	27	25	15		35
Container No.	A13	A15	1/23	V74	V46		V44
Wt· Sample Wet + Tare	107.16	101.19	104.15	103.88	116.	14 10	1167
Wt Sample Dry + Tare	96.32	91.35	94.33	94 51	106		13.35
Wt. Water	10.84	9.84	4.82	9.37			8.32
Tare Container	69.01	66.64	69.34	71.07	83.	.69	11.56
Wt of Dry Soil	27.31	24.71	24.99	23.44	23.	22.	21.79
Moisture Content w%	39.7	39.8	34.3	40.0	42	.3	38.2
	AVE	age Values		Plastic	Limit		
			Trial No.		/	2	3
	w	= 39.8	Container		BK	AN	AE
	w	= 32.8	Wt. Sample	Wet+Tare	60.2465	59.7074	64.1656
		2	Wt. Sample	Dry + Tare	58.5115	518007	61.4170
		7.0	Wt. Water		1.7350		
			Tare Cont	ainer	53.2661	51.9204	53.0899
	I <sub>f</sub>	2	Wt. of Dry	Soil	5.2454	5.8803	
	I,	=	Moisture Co			32.4	33.0
				Shrinkage	Limit		
			Trial No.				
			Container				ļ
42			Wt-Sample				
			Wt Sample !	ory + lare			
8			Wt-Water	ain a s			
			Tare Cont Wt. of Dry S				
E			Moisture Co				
₩ 41			Vol. Contain				
÷ 41			Vol. Dry Soi				
			Shrinkage V				
			Shrinkage L				
חב			2.	= w (Y	-Vo x 10	00)	
7 40 E					¥¥ o		
			Descriptio	n of Sam	ple:		
		Φ					
39							
			Remarks:	CURING	TIME	32.5 H	OURS.
		<u> </u>					
38							
7 8 9 10 15	20 25	30 40					
Number	of Blows						



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UNIVERSITY	of ALE	BERTA	PROJEC	1			
DEP'T of CIV	II FNGIN	FERING		- ( - 2 - 5			0 0
SOIL MECHANIC				ON			
ATTERBER	C	INALTO	HOLE	Oil	1404/1	DEPTH	KYLAND
ALIENDER	L	IIVIII5	TECHNI	CIAN 5.	121.	DATE	111/52
	Lic	uid Limit				DATE /3	77738
Trial No.			2	· · · · · ·			
No. of Blows	2/	2	3	4	5		6
Container No.	21	24	7	//	35		38
Wt. Sample Wet + Tare	V74	V72	V42	A15	V26		V24
	103.27	100.56	106.04	102 41	105		1215
Wt Sample Dry + Tare Wt Water	93.40	91.26	93.61	91.06	45.	-	101.47
	9.87	9.30	12.43	11.35	9.		10.11
Tare Container	71.07	69.97	67.38	66.64	73.	50	71.88
Wt. of Dry Soil	22.33	21.29	26.23	24.42		46.	24.09
Moisture Content w%	44.2	43.7	47.4	46.5	1 42	7	42.3
	THE AVA	age Values		Plastic	Limit		
	1-1-1-1-1		Trial No.		1	2	3
	w	= 43.7	Container		AN	AE	BE
	200	p= <u>37.4</u>	Wt. Sample	Wet+Tare	61.1283	63.5344	5.0263
		=	Wt. Sample				
			Wf. Water				
	ID.	= 6.3	Tare Cont	giner	51.9204	53 0849	54 3416
			Wt of Dry		6.7158		
47			Moisture C		37.1	37.6	37.6
	11	=		Shrinkage			
		711711111111111111111111111111111111111	Trial No.	Jiii iii ag c	2111111		
			Container	No.			
			Wt.Sample				
46			Wt Sample				
			Wt Water	317 1 1010			
8				ainar			
			Tare Cont				
E			Wt. of Dry S				
₩ 45			Vol. Contain				
0 0			Vol. Dry Soi				
O			Shrinkage \				
			Shrinkage L				
2							
7 44 0 0 0 W			w.	= w (Y	-Vo x 10	00)	
0	<del>                                     </del>			•	440		
Σ			Description	n of Sam	nla		
			Descripino	11 01 30111	p10		
43							
		<b>V</b>	Remarks:	CURING	TIME	199 H	OURS
7 8 9 10 15	20 25	30 40					
	of Blows						



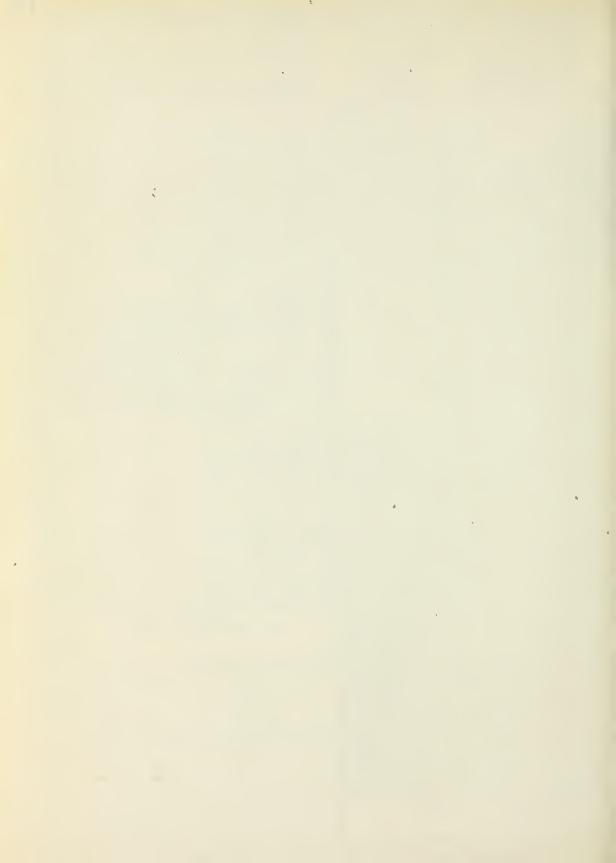
DEP'T. of CIVIL ENGINEERING SOIL MECHANICS LABORATORY ATTERBERG LIMITS   SAMPLE RAWFORD # 1		L	JNI	VE	R	SI	TY	1	(	of		1	ALE	BE	R	TA			PROJEC	T				
SOIL MECHANICS																			SITE	- 602	- 13.5		1 0	1.01
HOLE																								
TECHNICIAN S. DATE 4/2/2  Liquid Limit  rial No.  10. of Blows  33 29 31 8 8 75  ontainer No.  14. Sample Wet+Tare  10.3.44 766.38 16.6.41 160.34 101.24 11.47  14. Sample Dry+Tare  17. 31 16.74 17.26 16.45 11.47 16.61  18. The second of th																				011				1 LANID
10   No.		-	41	11	_ [	10		7	U	)			L	117	11	3			TECHNI	CIAN 5	Tal-	DATI	E -7	112/58
10   No.												_	Lie	qui	d	Li	mit							
0. of Blows 0. ontainer No.	rial	N	0.						T		/								3	4	5			6
## Sample Wet + Tare	10. 0	of E	3101	N S							33	3			2	29				8	8			
## Sample Dry +Tare	ont	ain	er	No						V	1	2			V	74			V72	A13	913	5	U	125
Vi. Water       (1/-3/)       (0.76)       (1/-26)       (0.45)       (1/-47)       (0.61)         gree Container       67.38       7/-07       69.97       64.01       66.64       84.86         Vi. of Dry Soil       25.25       24.35       25.18       20.88       25.15       21.43         toisture Content W%       44.8       45.0       44.7       50.0       49.6       49.5         Average Values       William Interest Solution (Container No. And BE Alexander)       Beautiful Trial No. And BE Alexander Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And BE Alexander)       Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beautiful Solution (Container No. And Beau	/t. S	Sam	ple	W	et.	+ T	ore	3		10	3.	9.	1		100	6.38	3	10	06.41	100.34	101.2	6	//	670
Average Values	VI. S	am	ple	Di	ry :	+ 7	cre	3		9	2-	6	3		93	5.4	2	9	75.15	89.89	69	79	10	6.24
1	-	-	-						_	_	-	_		1	10	.96	2	/	11.26	10.45	11	17	/	0.61
Average Values									-					-		1.0	7				66.	64		
Average Values  \[ \su_1 = 45.6 \\ \times_1 = 39.8 \\ \times_2 = \\ \times_3 = \\ \times_4 = \\ \times_5 = \\ \tim	Management Transport							-01	-			-		+			5							
Trial No.	1015	101	e	0	nte	nr	W	10	1		44	11	5		4	5.0		1	44.7			.6	4	79.5
Wi = 45.6							-	-				#	Ave	rag	18	Val	les	-						
Wp = 39.8   Wt. Sample Wet+Tare   58.7444   60.7422   59.87   Wt. Sample Dry + Tare   56.8702   58.9201   57.95   Wt. Water   7.9342   7.8273   7.92   7.92   7.92   7.92   7.92   7.92   7.93   7.92   7.92   7.93   7.92   7.93   7.92   7.93   7.92   7.93   7.92   7.93   7.92   7.93   7.92   7.93   7.9						-	1			-	+			-									-	
W   Sample Dry + Tare   Sc. 8102   S8.4201   S7.45     W   Water						-		-			#	#						1				-		AE
Total No   Wt Sample Wet + Tare   Wt Water   Tare Container   Si. 9204   St. 3916   St. 308					1	-						#	w	p= .	٥	3.1.8		-				7		
Ip = 5.8					+	#	$\Box$	+			$\Box$	#	W	= .			_	7						
Wi of Dry Soil   4.8898   4.5293   4.86     It =					#			-				#	Ĩ,	, =		5.8	_			diner	51 9201	543	916	
Shrinkage Limit  Trial No.  Container No.  Wt. Sample Wet + Tare  Wt. Water  Tare Container  Wt. of Dry Soil Wo.  Moisture Content w%.  Vol. Container  Vol. Container  Vol. Container  Vol. Container  Shrinkage Vol. V-Vo.  Shrinkage Limit Wg.  Wg. = w (Y-Vo. x 100)			-		1	-		-				4						Wf	of Dry					
Shrinkage Limit  Trial No.  Container No.  Wt. Sample Wet + Tare  Wt. Sample Dry + Tare  Wt. Water  Tare Container  Wt. of Dry Soil Wo.  Moisture Content w.%  Vol. Container  Vol. Container  Vol. Dry Soil Pat Vo.  Shrinkage Vol. V-Vo.  Shrinkage Limit Ws.  Ws. = w (Y-Vo. x 100)			-		7	-	11	+				#												39.5
Trial No.  Container No.  Wt. Sample Wet + Tare  Wt. Sample Dry + Tare  Wt. Water  Tare Container  Wt. of Dry Soil Wo.  Moisture Content w.%  Vol. Container  Vol. Dry Soil Pat Vo.  Shrinkage Vol. V-Vo.  Shrinkage Limit Wg.   Ws. = w (Y-Vo. x 100)			-		7	+	-	+				1	14	= .										
Container No.  Wt. Sample Wet + Tare  Wt. Sample Dry + Tare  Wt. Water  Tare Container  Wt. of Dry Soil Wo  Moisture Content w.%  Vol. Container  Vol. Dry Soil Pat Vo  Shrinkage Vol. V-Vo  Shrinkage Limit Ws  Ws = w (Y-Vo x 100)			-		-	+		+			+	1			пп	mi		Tri						
Wt. Sample Dry + Tare  Wt. Water  Tare Container  Wt. of Dry Soil Wo  Moisture Content w.%  Vol. Container  Vol. Dry Soil Pat Vo  Shrinkage Vol. V-Vo  Shrinkage Limit Ws   Ws = w (Y-Vo x 100)					4	+	1	+	-	H	$\mp$	-						-		No.				
Wt Water Tare Container Wt of Dry Soil Wo Moisture Content w.% Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-Vo Shrinkage Limit Ws   W = w (Y-Vo x 100)			-			+		1	+		$\prod$	T		$\prod$				W1	Sample	Wet + Tare				
Tare Container  Wt. of Dry Soil Wo  Moisture Content w.%  Vol. Container V  Vol. Dry Soil Pat Vo  Shrinkage Vol. V-Vo  Shrinkage Limit $w_s$ $w_s = w_s \left( \frac{V - V_o}{W_o} \times 100 \right)$		-	1		-	-		1			H	-						Wt.	Sample	Dry + Tare				
Wt. of Dry Soil Wo  Moisture Content $w^{\circ}$ /o  Vol. Container V  Vol. Dry Soil Pat Vo  Shrinkage Vol. V-Vo  Shrinkage Limit $w_s$			-			-		+			+	T		H				1				-		
Moisture Content $w^{\circ}$ ,  Vol. Container V  Vol. Dry Soil Pat Vo  Shrinkage Vol. V-Vo  Shrinkage Limit $w_{s}$ $w_{s} = w_{s} = w_{s} = w_{s} = w_{s} = w_{s}$	50	, E	•	H	-	-	+-		+			+						17						
Shrinkage Vol. V-Vo Shrinkage Limit $w_s$ $w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$	-	E	<b>A</b> -				-	+			+	Ŧ		-				-				-		
Shrinkage Vol. V-Vo Shrinkage Limit $w_s$ $w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$	e a		1						$\perp$									7						
Shrinkage Vol. V-Vo Shrinkage Limit $w_s$ $w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$	n o	F	+-	A	7	+	+		+		$\mathbb{H}$	+										-		
Shrinkage Limit $w_s$ $w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$	ပိ		-		-	1	H					+						-						
$w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$	48	<b>=</b>				A	1				$\pm$	+												,
						-		7	$\pm$	H		+		1							/ \/			
	D C							1	X			$\perp$							$w_{s}$	= w (-)	W <sub>o</sub> x I	00)		
Description of Sample:	0		-			-			+			+												
	Σ						$\perp$					1						D	escriptio	on of Sam	ple:			
46	46	-										1		Ш	Ш			_						
		上			_	+			+			+		#	Ш			H _						
		上				-			1			+						H -						
						+			1			+		#	Ò			-				10.		/
Remarks: CURING TIME 690 HOURS		F	=			-			-									R	lemarks:	CURING	TIME	690	1	OURS
44	44	1	=						1			+		#				-						
		F	+						+			+						-						
2 2 2 2 2 2 3 2 4 2			上								Д	1			1	Ш	40	4 -						
7 8 9 10 15 20 25 30 40		7	8			m	bei			f					30		40							



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raine.	I No.					_						+				_		1		+						
-	of Blo lainer					-						+						$\vdash$		+						
_	Sampl		-	+ T	nre				-	_		+			_			-		-						
-	Sampl		~							-		+			_			$\vdash$		+-					-	
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				-		-		#	-	H	w								t Sampl							
				+		-	H		+	1	w	3 3	-		_		_		/t Water				2.0139			2.1146
	H	1		-			1	+	Ŧ	H	1 <sub>r</sub>	, =				_			are Con							52.0623
			-	-		+	H	H	1	H			_						tof Dry							7.3970
									I				_					IN	oisture	Cont	tent %	10	27.2	28	.4	28.6
									$\pm$	$\mathbf{H}$	11			_	-		-			Sh	rinkag	е	l_imit			
									+	4	П	П	Ш	Ш	П	Ш	Ш	1	rial No-							
			1	+		#		$\parallel$	‡			H		Ш	#	Ш			ontainer	No		_				
			+	$\pm$		+			#			1		Щ					/t·Sample							
			-	+		1		+	+			H		$\parallel$				ш—	/t· Sample	Dry	/ + lare	+				
		1	1	+	##	+		$\Box$	+			H						-	t.Water are Con	tain	er	+				
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	上		1		++	1			+	H		#			#		Ш	118	hrinkage							<u>,                                      </u>
	崖		1			#													2.	/s =	w (	V-	-Vo x 10	(00		
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		+	+	+	H	+	H	H	+	H																
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UNIVERSITY of ALE	ERTA	PROJEC	T			
		SITE				
DEP'T of CIVIL ENGIN			CRAWF			
SOIL MECHANICS LABO			ON 169			F-Y 175N
ATTERBERG LI	MITS	HOLE	01401		DEPTH	-
		TIECHNI	CIAN no	Mi	DAIL	3.12/58
Liq	uid Limit					
Trial No.	2	3	4	5		É
No. of Blows 35	36	25	27	16		18
Container No. U24	V74	V-71	V46	V-4	9	37
Wt. Sample Wet + Tare 94.74	86.21	98.14	103.96	74.5	4 9	5.18
Wt. Sample Dry + Tare 90.44	8236	91.23	98.58	88.		3365
Wt. Water 4.30	3.85	6.91	5.38	6	-	6.53
Tare Container 77.88	71.07	72.41	83 69	71.:		66.62
Wt. of Dry Soil 22.56	11.29	18.82	1489	16.		17.03
Moisture Content w% 19.0	34.1	36.7	36.1	38.		38.4
		1				
Aver	age Values		Plastic I			
		Trial No.		/	2	3
		Container		BE	28	24.20
w		Wt. Sample				
We was	2	Wt. Sample				
	-0	Wt. Water		1.5450	2.6096	1.8162
كالكالكا الأن من لها أن الأركار أنه في يبدر البناء في أنبي المناه والنبية الكالكا	= 5.8	Tare Cont	ainer .	54 3916	36.0319	36.8238
If		Wt of Dry	Soil	7.5321	7.2531	7.1532
Ta I	# # # # # # # # # # # # # # # # # # #	Moisture C	ontent %,	* 20.5	36.0	25.4
	-		Shrinkage	Limit		
38		Trial No.				
		Container	No.			
		Wt. Sample	Net + Tare			
		Wt Sample I				
		Wt-Water				
<b>8</b> <sup>8</sup> 37		Tare Cont	giner			
		Wt. of Dry				
=		Moisture Co				
o u te u t		Vol. Contai				
0		Vol. Dry So				
0		Shrinkage \				
36		Shrinkage l				
2				V		
2		W.	= w (Y	-Vo x 10	00)	
Moistu				,,,		
Σ		Description	n of Sam	nle:		
35		Descriping	01 30111	P1C		
		Domarks.	CURING	TIME	1 Ho	UR
24	Φ	Kelliotks:	- VICING	. ,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	<u> </u>
34						
7 8 9 10 15 20 25 Number of Blows						
Number of Blows	,					
		13				



UNIVERSITY	of ALE	RERTA	PROJEC	T			
			SITE				
DEP'T of CIVI				CEARF			
SOIL MECHANIC				ON Mass			FLY ASH
ATTERBER	G L	IMITS	HOLE	CIAN 4		DEPTH	
			TECHNI	CIAN 4 11	7(	DATEZ	3/12/58
	Liq	uid Limit					
Trial No.	/	2	3	4	5		6
No. of Blows	33	32	35	14	16		14
Container No.	V66	071	A30	V63	A12	e   1	121
Wt Sample Wet + Tare	106.83	107.75	104.53	101.53	966	.7 /1	0444
Wt. Sample Dry + Tare	96.65	48.86	46.22	72.39	89-8	38	16 09
Wt- Water	10 18	8.89	8.31	9.14	6.7	79	8.35
Tare Container	66.41	72.04	71.10	61.77	71.:	36	72.61
Wt. of Dry Soil	30.24	2682	25.12	24.62	18.	52	23.28
Moisture Content w%	33.6	33.2	33.1	37.1	36.	6	35.9
		aga Values		Plastic	Limit		
		aga Values	Trial No.		/	2	3
		= 34.6	Container		BK	AM-BJ	8Y-82
	w	b= 26.8	Wt. Sample		59.1565	54.0362	60.3272
			Wt. Sample				
		=	Wt. Water			1.5694	
	Ip.	= 7.8	Tare Cont			51.6100	
	I.	2	Wt of Dry	Soil	4.6684	5.7968	
		2	Moisture C	ontent %	26.2	27.1	21.2
	11			Shrinkage			
37			Trial No.				
			Container	No.			
			Wt Sample				
			Wt Sample !				
			Wt. Water				
<b>%</b> 36			Tare Cont	ainer			
	7		Wt. of Dry S				
G			Moisture Co	ntent w%			
c			Vol. Contai	ner V			
0 O			Vol. Dry Soi				
35			Shrinkage \				
0			Shrinkage L	_imit ws			
5	HHA			. (V	-Vo . 10	100	
Moistu			$W_{s}$	= w (Y	Wo	,0,	
O W							
34			Descriptio	n of Sam	ple:		
			-				
33		<b>**</b>	Remarks:	CURING	IME	6 HOL	RS.
3 0 0 10	20 25	30 40					
7 8 9 10 15 Number	of Blows	30 40					
144111001	3.0						
							_



UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE CRAWFORD - #4 SOIL MECHANICS LABORATORY LOCATION 1.0% NIME + 20% FLY. ASH DEPTH HOLE ATTERBERG LIMITS TECHNICIAN 10 d 10 DATE 24/12/58 Liquid Limit Trial No. No. of Blows 42 43 45 16 16 Container No. 171 A23 V74 124 V40 V66 Wt. Sample Wet + Tare 95.61 94.95 40.36 95.06 97.60 104.88 Wt. Sample Dry + Tare 89 62 93.07 83.47 87.08 90.22 41.72 Wt. Water 5.49 7.38 746 688 6.39 7.98 Tare Container 66.41 72.04 72.12. 65.12 71.07 11 88 Wt. of Dry Soil 17.58 14.15 14.54 20.35 18.85 20.67 Moisture Content w% 34.1 33.8 33.9 38.2 38.6 38.5 Plastic Limit Average Values Trial No. 3 W;= 36.4 Container No. AE 22 AT Wp= 29.6 Wt. Sample Wet+Tare 46.2921 64.3337 63.0364 Wt. Sample Dry+Tare 43.8888 61.8978 60.7701 Wt. Water 2.4033 2.4359 2-2663 In = 6.8 Tare Container 35.7490 537176 53.0899 L<sub>f</sub> \* \_\_\_\_\_ Wt of Dry Soil 8.1398 8.1802 7.6802 38 Moisture Content 29.5 29.8 29.5 Shrinkoge Limit Trial No. Container No. Wt. Sample Wet + Tare 37 Wt. Sample Dry + Tare Wt-Water Tare Container Wt of Dry Seil W. Content Moisture Contant w % Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-Vo Shrinkage Limit We Moisture 32 Ws = W ( V-Vo x 100) Description of Sample: \_\_ 34 Remarks: CURING TIME 24 HOURS 33 <del>|</del>7 25 40 8 9 10 20 15 Blows of Number



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		-	41	11		70	ם כ	. $\Gamma$	16	7			Ē	IIV	11	1	2			TE	CHN	ICI	ANA	7	il	DAT	E 3	1/12/	58
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Tri	al	N	0 ·						T		/			T	-	2				3		1	-1	T	5			6	
VO	. 0	f E	3101	v S					T		41			1	-	40				46			1-7		13			/3	
Co	nt	ain	er	No						V	14	2				58				V21			126		V30		1	774	
Wt	·S	am	ple	W	et	<b>+</b> T	ar	e		//	0.	5	7		10	7.9	15		/	05.	68	1	06.63		103	96	1	16.01	
Wt	·S	a m	ple	Di	ry	+7	ar	8		9	9.	40	,		9	3.0	67			97.	31		9723		44	13		16.15	-
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	_	_	-			_	-		+		H	-	#	$\prod$	11				11				t + Tare						
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UNIVERSITY of ALBERTA SITE DEP'T of CIVIL ENGINEERING SAMPLE CRAWFORD - #40 & SOIL MECHANICS LOCATION 1.090 NIME + 20% FLY. ASH LABORATORY DEPTH LIMITS ATTERBERG TECHNICIAN of it DATE 2811/54 Liquid Limit rial No. 2 10. of Blows 24 44 13 75 25 13 Container No. V-6 V-63 V42 V49 168 166 Vt. Sample Wet + Tare 112 95 93.29 100.15 88.88 9364 95 83 Wt. Sample Dry + Tare 86.28 93.65 82 71 85-82 88.62 105.32 Nt. Water 7.01 6.17 782 7-21 7 63 6.50 Tare Container 87.12 71.56 67.77 76.74 67 38 66.41 Vt. of Dry Soil 19.41 17.06 18.20 18.51 15.33 1691 Moisture Content w% 37.8 38.4 40.3 40.2 42.3 41.9 Plastic Limit Average Values 3 Trial No. w= 40.0 Container No. 23 HE BW wp= 28.4 Wt. Sample Wet+Tare 45 6894 62.4126 63.8337 Wt. Sample Dry + Tare 43 6595 60. 4251 61. 8955 Ws = \_\_\_\_ Wt. Water 2.0299 1.9875 1.4382 Ip = 11.6 Tore Container 36.2967 53 4418 54.7360 L<sub>f</sub> \* \_\_\_\_\_ Wt of Dry Soil 7.3628 6.4833 7.1595 42 Moisture Content % 27.6 + 30.6 Shrinkage Limit Trial No. Container No. W1 Sample Wet + Tare Wt Sample Dry + Tare Wt Water Tare Container Wt. of Dry Soil W. 100140 2000 Moisture Content w% Vol. Container Vol. Dry Soil Pat Vo Shrinkage Vol. V-V. Shrinkage Limit We  $w_s = w \left( \frac{V - V_o}{W_o} \times 100 \right)$ MO181 Description of Sample:\_ 38 Remarks: CURING TIME 866 HOURS 37 25 30 40 20 8 9 10 . 15 Number of Blows



UNIVERSITY O		PROJECT						
DEP'T of CIVIL		SAMPLE RANFORD - #40 &						
SOIL MECHANICS LABORATORY LOCATION 2.0% 2005 + 4.0% Fax 4/3								
ATTERBERG LIMITS HOLE TECHNICIAN POLITION DATE 23/11 58								
Liquid Limit								
Trial No.	/	2	3	4.	5		. 6	
No. of Blows	15	16	23	24	3,		39	
Container No.	V23	142	A15	A13	1/35		168	
Wt· Sample Wet + Tare	110.11	104.17	102.35	104.49	101.5	58 /	15.24	
Wt Sample Dry + Tare	100.21	95.33	43.18	46.00	7.7.	94.45 108		
Wt· Water	9.90	8.84	8.51	8.49	7.	13	6 34	
	64.34 .7.3		66.64	04.01	10	76	81.12	
	33.87	27.45	27./4	26.99			2183	
Moisture Content w%	32./	31.6	31.6	31.4	30	./	29.0	
	Aver	age Values		Plastic	Limit		1	
	+	= 30.9	Trial No.	1	/	2	3	
	1 [ ] ] ] ]	•	Container		23	22	30	
		= 24.3	Wt. Sample					
	Ws	=	Wt Sample Wt Water					
	1,	= 6.6	Tare Cont				21710	
		*	Wt. of Dry				8.8520	
	11111		Moisture C					
	11	=		Shrinkage				
33			Trial No.	31111114490				
			Container	No.				
			Wt Sample					
			Wt Sample !					
			Wt Water					
32			Tare Container					
			Wt of Dry Soil Wo					
C			Moisture Content w%					
ontent	1		Vol. Centai					
0			Vol. Dry So				-	
31			Shrinkage \Shrinkage				-	
o l								
Moist			Ws	= w (-1	<u>W∘</u> x 10	00)		
× ×		- N	Description of Sample:					
30								
			1					
				~ ~			<u></u>	
Remarks:URING Time I Hour							OUR	
29								
3 0 0 10 15								
7 8 9 10 15 20 25 30 40 Number of Blows								



UNIVERSITY	of ALE	BERTA	SITE				
DEP'T of CIVIL ENGINEERING							
					172 4		
SOIL MECHANICS LABORATORY LOCATION 2000 A FAN ASA							
ATTERBERG LIMITS HOLE TECHNICIAN BUT DATE 23/12 50							1.17 60
	lic	uid Limit	112011101	OTAIL 771E		DAILA	1782 38
Trial No.	/		3	4	1 -		,
No. of Blows	15	2		20	5		6
Container No.			20		32		32
Wt. Sample Wet + Tare	V65	A23	V41	130	USE		VW
	106.24	108.80	96.47	44.01	84		108.11
Wt Sample Dry + Tare	96.92	100.03	88.73	71.70	81.5		100 43
Wt. Water	9.32	8.78	7.74	7 //	3		7 24
Tare Container	67.85	72 72	64.01	67.10	69.1		76.74
Wt of Dry Soil	24.07	27 31	24.72	2280	11.		24.19
Moisture Content w%	32.1	32.2	3/.3	31.2	30.434	<del>2</del>	29 9
	Aver	age Values		Plastic	Limit		
			Trial No.		/	2	3
		30.81	Container	No.	BG+BA	AH	AE
	w	p= 24.0	Wt. Sample	Wet+Tare	62.4511	60 0660	62.1845
			Wt. Sample	Dry + Tare	60.4463	58.5224	60.4438
	1 1 1 1 1 1 1	3	Wt. Water		2.0048	1.5436	1.7457
	Ip	= 6.8	Tare Cont	ainer	52.2528	52.0623	53 08 99
	T <sub>6</sub>	=	Wt of Dry	Soil	8.1935		7.3539
			Moisture C			23.9	23.7
	11	2		Shrinkage			
			Trial No.				
			Container	No.			
			Wt-Sample				1
	Wt Sample Dry + Tare						
			W1. Water				
8°32			Tare Container				
3~			Wt. of Dry Soil Wo				
=			Moisture Content w%				
0			Vol. Container V				
t c o o o			Vol. Dry So				
			Shrinkage V				
31			Shrinkage l				
Lure				(1)	/-\/-	1	,
sto			2/3	= w (1	Wo X IC	20)	
Moist		1 0					
			Description	n of Sam	ple:		
30							
		2	Remarks:	CURING	TIME	6 HO	VRS
29		2 1 2 1 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 3					
7 8 9 10							
Number	of Blow	S					
			TI.				



UNIVERSITY of ALBERTA PROJECT								
DEP'T of CIVIL ENGINEERING SAMPLE CRAWFORD # + &								
SOIL MECHANI			SAMPLE	ON 2.0%	04: (	** 4		
				JIV 2.0%		DEPTH	- Y HSM	
ATTERBERG LIMITS HOLE DEPTH TECHNICIAN PLAN DATE 24 1721							11/2/58	
	Lic	uid Limit	1					
Trial No.	/	2	<i>Ē</i> '	-4	5		2	
No. of Blows	16	24	26	28	42		4 1/2	
Container No.	V68	H30	V37	V72	162		A15	
Wt. Sample Wet + Tare	130.07	109.88	108.87	110.62	105.		103.04	
Wt Sample Dry + Tare	114.00	100.13	78.17	100.67	95.		73 23	
Wt Water	11.01	9.75	10.70 9.95 7.42			486		
Tare Container	87.12	71.10	66.62 69.97		65.62		66.64	
Wt. of Dry Soil	31.88	24.03	31.55	30.70	30.1	8.1	26.59	
Moisture Content w%	34.7	33.6	34.0	32.4	30.	5	3711	
	AVA	age Values		Plastic	Limit			
			Trial No.		/	Z	3	
		1= 33.0	Container		BK	30	27	
	w	p= 25.7	Wt. Sample					
		=	Wi Sample	Dry + Tare				
		= 7.3	Wt Water			1.2410		
			Tare Cont			36.5148		
		z	Wt of Dry Moisture C			49288		
	It	-				23.2	24.4	
38			Trial No.	Shrinkage	Limit			
			Container	No.				
			Wt Sample				-	
			Wt Sample					
			Wt-Water					
8 36		أأنا للللا بدارة الأك	Tare Cont	giner				
			Wt of Dry Soil Wo					
E .			Moisture Content w%					
o o o o o o o o o o o o o o o o o o o			Vol. Contai					
° C			Vol. Dry So					
34			Shrinkage '					
·			Shrinkage I					
Moistur			w <sub>s</sub>	= w (1	<del>/-V</del> ° x 10	00)		
			Description of Sample:					
32			1					
			Deparks		·	2 - 11	00	
Remarks: CURING TIME						24 M	OUKS	
30								
7 8 9 10	5 20 25	30 40						
7 8 9 10 11 Number								



UNIVERSITY	PROJECT							
DEP'T of CIV	SAMPLE CKANFORD - #40 #							
SOIL MECHANIC	LOCATION 2.0% NINE + + C% FLY - HON							
ATTERBERG LIMITS			HOLE	HOLE DEPTH TECHNICIAN S. C. DATE 31/12 5				
ATTENDE	1. 2.	DATE	1112 58					
Liquid Limit								
rial No.	/	2	3	4	5		6	
o. of Blows	19	21	20	42	42		45	
ontainer No.	V46	149	A23	V72	V-70	2	V71	
Vt. Sample Wet + Tare	119.47	112.06	103.02	10402	7-1	68 9	18.23	
Vt. Sample Dry + Tare	109.70	101.01	94.88	45.33			71.74	
Vt. Water	9.77	11.05	8.14	8 64	1		6.51	
Tare Container Wt- of Dry Soil	83.69	71.56	72 72	64.47	65		72.04	
Noisture Content 25%	37.6	37.5	22.16 36.8	25.36			331	
.0.01010 00.11011 0076		37.3			33.9 33.1			
	Aver	age Values	T : 1 at	Plastic L	_IMIT	-7	3	
	w	= 36.2	Trial No.		82	2 4M + B I	BA+Ba	
		-	Wt. Sample					
	ω,	p= 26.8	Wt. Sample					
	1 1 1 1 1 1 1	2	Wt Water				1.6161	
	\$p =		Tare Cont					
	I,	*	Wt. of Dry	Soil	5.4871	6.5732	5.9533	
		=	Moisture C	ontent %	26.8	26.5	27.1	
				Shrinkage	Limit		,	
	1111		Trial No.					
			Container No.					
37			Wt Sample Wet + Tare Wt Sample Dry + Tare					
8			W1 Water Tare Container					
			Wt. of Dry Scil W.					
=			Moisture Content w%					
36			Vol. Container V					
0			Vol. Dry So	il Pat Vo				
			Shrinkage \	Vol. V-V.				
			Shrinkage l	Limit ₩3				
2 35 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			w <sub>s</sub> = w ( <del>y-v°</del> x 100)					
Σ			Description of Sample					
34								
			Remarks: CURING TIME 193 HOURS					
		2						
33	20 25	30 40						
7 8 9 10 15 20 25 30 40 Number of Blows								
			M					



UNIVERSITY of A	BERTA	PROJEC	Ι			
DEP'T of CIVIL ENG	INEERING		ER AWFO	24:0 -	# 40 E	
SOIL MECHANICS LA			ON 2-0%			
ATTERBERG		HOLE		,	DEPTH	
ATTENBENG	LIMITS	TECHNI	CIAN M.	I sh	DATE 2	81.154
L	iquid Limit					
Trial No.	2	3	4	5		6
No. of Blows 16	14	14	38	38		36
Container No. A30	V25	V40	V47	V69		V41
Wt. Sample Wet + Tare 1/3.04	116.74	102.86	10399	106.7	7/ /	07.46
Wt. Sample Dry + Tare 100.71	107.41	91.82	92-86	96.4		97.65
Wt. Water /2 33	9.33	11.04	11 13	10.2		981
Tare Container 71.10	84.86	65.12	64.01	69.3		72.41
Wt. of Dry Soil 29.61 Moisture Content w% 41.6	22.55	26.70	28.85	27.0		25.24
Moisture Confent w% 41.6	1 41.4	41.4	38.6		0	38.9
Av	erage Values		Plastic			
	wi= 39.6	Triol No.		/	2 BK	3
		Container Wt Sample		28		AH 6/1954
	wp = 33.9	Wt. Sample				
	√s =	Wi Water				
	p = 5.7	Tare Cont				
	If "	Wt of Dry				
	I+ =	Moisture C			34.3	
	*1		Shrinkage	Limit		
		Trial No-				
		Container	No·			
		Wt. Sample				-
		Wt Sample	Dry + Tare			-
3,42		Wt-Water	-1		<u> </u>	
42		Tare Cont				
		Wt- of Dry				
Tu u u u u u u u u u u u u u u u u u u		Vol. Contai				
		Vol. Dry So				
o .		Shrinkage '	Vol. V-V.			
40		Shrinkage I	_imit Wg			
ture		2.	= w (1	/-Vo_x 10	00)	
ntsio W	0			****		
38		Description	on of Sam	ple:		
						,
		Remarks	CURING	TIME	866 H	OURS
36						
3 2 2 12 15 22	25 30 40					
7 8 9 10 15 20 Number of Blo						



UNIVERSITY	of ALE	BERTA	PROJECT							
DEP'T of CIV			SITE	SAMPLE CRAWFORD - #40 4						
SOU MECHANIC	IL ENGIN	CATORY					~			
SOIL MECHANIC	S LABO	RAIDRY	HOLE	ON 3.5			LLY- HISH			
ATTERBER	G LI	MIIS	TECHNI	CIAN M.	121.	DATE	1/12,50			
	Lig	uid Limit		7,10			3/12/36			
Trial No.	/	2	3	4	5		6			
No. of Blows	7	8	7	36	34		32			
Container No.	V72	V26	V25	V70	V50		U61			
Wt. Sample Wet + Tare	112.58	119.01	123.78	104.01	107	31	79.17			
Wt Sample Dry + Tare	101.50	107.17	113.75	98.10	101.		7186			
Wt. Water	11.08	11.84	10.03	5.31	6.	25	7.31			
Tare Container	69.97	15.50	84 86	68.70						
Wt of Dry Soil	31.53	33.67	28.84	50.	2296					
Moisture Content w%	35.2	35.2	34.8	32.1	32.	/	31.4			
	Aver	age Values		Plastic	Limit					
	1-1-1-1		Trial No.		/	2	3			
	w.	= 32.7	Container	No.	AD-AV	AT	27			
	w	27.7	Wt. Sample	Wet+Tare	62.6316	63 4491	48.3483			
	1 1 1 1 1 1 1 1 1	=	Wt. Sample	Dry + Tare	60.6732	61.4311	46.0419			
	1 1 1 1 1 1 1		Wt Water		1.9584	2.0120	2.3064			
	I <sub>p</sub>	= 5.0	Tare Cont	ainer	53 65 48	53.7176	31.7263			
	4	#	Wt of Dry	Soil	7.0184	7.7195	6.3156			
	I.	=	Moisture Co	ontent %	27.8	* 26.0	27.7			
				Shrinkage	Limit		·			
			Trial No.							
			Container	The second secon						
35			Wt.Sample \							
			Wt Sample [	ory + Tare						
8			Wi Water				-			
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Tare Cont							
-			Wt of Dry S Moisture Co							
÷ 34			Vol. Contain							
6			Vol. Dry Soi							
°			Shrinkage \							
			Shrinkage L							
2					, V	\	,			
in 33			Ws	= w ( <u>y</u>	W. x 10	(00				
W 33										
			Descriptio	n of Sam	ple:					
		90								
32		• \								
			Remarks:	CURING	TIME	1 Hou	R			
21										
7 8 9 10 15										
Number	of Blows									

PROJECT

UNIVERSITY of	ALB	ERTA	PROJEC	T			
DEP'T of CIVIL E	NGINI	EERING		CEANF	(ABD = )	¥ 4.0 6	
SOIL MECHANICS				ON 35			
ATTERBERG			HOLE	CIAN A		DEPTH	
ATTENDENO	L_ 1	141113	TECHNI	CIAN	1 2	DATE 2.	3/12/50
	Liq	uid Limit					
Trial No.		2	3	4	5		6
Vo. of Blows 44	-	45	42	17	17		17
Container No. VE.	′	V40	AII	164	169		162
Wt. Sample Wet + Tare 106.	34	89.58	103 34	91.91	74.2	./ .	11.43
Wt Sample Dry + Tare 99		83.50	95.01	85.27	87.0		84.45
Wf Water 7.		6.08	8.33	6.64	6.5		6.98
Tare Container 76.		65.12	69.69	66.77	64.3		05.02
Wt. of Dry Soil 22.		18.38	25.32	18.50	18.2		19.43
Moisture Content w% 33	5 1	33.1	32.9	358	36.0	2	36.0
	Aver	age Values		Plastic			
	1	= 34.8	Trial No.		/	2	3
	H W	3 ( 0	Container	No.	HK-AV	bn	BL
	wp	= 26.8	Wt. Sample				
	1 Ws	= 26.8	Wt Sample				-
		8 ^	Wi Water				
	1				53.7869 54.7360 6.9293 8.0018		
	П.		Moisture C				
	∄ It	=		Shrinkage		1	~~~
	1		Trial No.	Similarage	L-111111		
			Container	No.			
			Wt. Sample				
36			Wt-Sample I				
			Wt Water				
8			Tare Cont	ainer			
			Wt. of Dry	Soil W.			
=			Moisture Co	ntent 45%			
±35 c			Vol. Contai				
0			Vol. Dry So				
			Shrinkage :				
2			Shrinkage l	_imit Wg			
5934 0 E				= w (Y	,,,,		
			Description	n of Sam	ple:		
33							
			Pomarks:	CURINO	- Time	e / H	nues
			Kemurks:	CERINO	7 / ////	6 7	0025
32	0 25	30 40					
	Blows						



UNIVERSITY of	ALBERTA		PROJECT						
DEP'T of CIVIL E	NGINEERING		SAMPLE - RAINFORD - #40 \$						
SOIL MECHANICS			LOCATION 3.5% NIME + 1.0% FLY - FISH						
ATTERBERG									
ATTENDENO	LIMITS		TECHNI	CIAN, 5	. 21	DATE	12.58		
	Līquid Lim	nit							
Trial No.	2		3	4	5		6.		
No. of Blows 15	17		21	23	29		31		
Container No. Al	3 V6.3		V+6	V65	12.	3	V47		
	63 101.01		112-02	97.23	100.8	8 9	8.55		
	49 92.85		05.22	90.14	93.5		10.56		
	14 8.16		680	7.09	7.3		7.49		
	01 67.77		83.69	67.85	61.3		6401		
	48 25.08		21.53	22.29	24.1		76.55		
Moisture Content Wio 37	.8 32.5		31.6	31.8	30.		30.1		
	Average Value	es -		Plastic					
	Wz= 31.1	Tr	ial No.		/	2	3		
			ntainer		23	28	AL' + AV		
	wp= 24.5	W1		Wet+Tare Dry+Tare					
	ws =		· Sample · Water			1.7956			
	tp = 6.6	- Ta		ainer					
	L =	17		Soil					
	11 .	0.0		ontent %					
	It =	-		Shrinkage					
	†  	mm Tr	ial No.						
		+++++++++++++++++++++++++++++++++++++++	ntainer	No.					
		WI	Sample	Vet + Tare					
		Wt	Sample !	ry + Tare					
8		V <sub>2</sub> 1	t-Water						
			re Cont						
-		1 1 1 1 2	tof Dry S						
ontent		7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7		ntent w%					
		11111	1. Contain	ner V					
S -		+ 1-1-1-1-1-1		/ol. V-V.					
32			rinkage L						
ē o	\				/	`	,		
2	<b>♦\</b>		Ws	= w (Y	- √° x 10	00)			
Moistu									
		)	escriptio	n of Sam	ple:				
31									
		_							
		#### -							
		-		2					
			Remarks:	CURING	IIME	24 H	OURS		
30		-							
		-							
	2 25 72								
	O 25 30 4 Blows	40   -							
Manipot		-							



UNIVERSITY of AL	BERTA	PROJEC	ī			
DEP'T of CIVIL ENGI	NEERING	SITE	ERAN FO	P1 - 10	1	
SOIL MECHANICS LAB			ON 3.5%			
ATTERBERG L		11101 5			DEPTH	
ATTENDENO	. IIVII I S	TECHNI	CIAN 5		DATE 3.	12.58
L	quid Limit					
rial No.	2	Ĵ	4.	5		6
lo. of Blows /2	16	15	34	35		33
ontainer No. 169	V37	166	430	A15		147
11. Sample Wet + Tare 110.07	104.44	101.41	105.13	102.		02.34
VI. Sample Dry + Tare 98.90	14.36	91.82	46 56	931		92.81
Vt. Water /1.17	10.13	9.59	8.57	8.	96	753
are Container 69.34	66 62	66.41	71.10	66.	64	04.01
Vt. of Dry Soil 29.51	27.74	25.41	25 46	26.	81.	28 14
ioisture Content w% 37.8	36.6	378	33.6	33.	4	33.2
	rage Values		Plastic	Limit		
		Trial No.		/	2	3
	72= 35.0	Container		AV-AK		AI
· · · · · · · · · · · · · · · · · · ·	p= 27.4	Wt. Sample				
	s =	Wt. Sample				
	-	Wt. Water		1.8641	1.8433	1.8938
	$p = \frac{7.6}{}$	Tare Cont				
38	f *	Wt. of Dry				
	t =	Moisture C			27.0	27.9
			Shrinkage	Limit		
		Trial No.				
	D	Container				
37		Wt. Sample				
		Wt Sample	JIY T IOIE			
8		Wt Water Tare Cont	giner			
		Wt of Dry				
=		Moisture Co				1
36		Vol. Contai				
36 c c O		Vol. Dry So				
		Shrinkage \	101. V-V.			
		Shrinkage L	imit ws			
			CV	- Va 16	201	,
in 35		$w_s$	= w (Y	Wo X II	10)	
35						
		Descriptio	n of Sam	ple:		
34	<u> </u>					
		D. marka		-7-	10,11	1/21.05
	( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )	Remarks:	CURING	IIME	176/2	HOURS
		-				
	φ \					
7 8 9 10 15 20 2	5 30 40					
Number of Blow						
•						



UNIVERSITY	of ALE	BERTA	PROJECT							
DEP'T of CIV			SITE	~~~						
				CRHWFO			22.4			
SOIL MECHANIC	C	MAIDRI		HOLE / DEPTH						
ATTERBER	L L	11111115		CIAN 5 U	ii.	DATE 2	9/1/59			
	Lio	uid Limit								
rial No.	/	2	3	4	5		6			
lo. of Blows	16	16	20	33	31		31			
ontainer No.	V65	H15	AII	V30	V35		913			
Vt. Sample Wet + Tare	103.36	103.83	103.22	103.29	1031.	15 /	00 05			
Vt. Sample Dry + Tare	93.10	43.16	93.60	73 86	44.	18	71.57			
Vt. Water	10.26	10.67	962	7.43	8.4	7	8 48			
Tare Container	67.85	06.64	69.69	69.10	70.		04.01			
Vt. of Dry Soil	25.25	26.52	23.41	24.76	23	62.	72.56			
Noisture Content w%	40.6	40.2	40.2	38.1	38	0	37.6			
	Aver	age Values		Plastic	Limit					
	+++++		Trial No.		/	2	3			
		i= 39.1	Container		30	82	27			
		p= <u>30.3</u>	W1. Sample							
	$w_{\rm s}$	=	Wt Sample Wt Water							
	10	= 8.8			2.4630		37.7263			
			Tare Cont Wt of Dry	Soil	8.2473	6.9621	6.7069			
	1 1 1 1 1 1 1		Moisture C			30.5	30.4			
-	11	=		Shrinkage						
			Trial No.	Julianago						
			Container	No.						
	<b>6</b>		Wt-Sample \							
			Wt Sample (							
	<b>6</b>		Wt. Water							
40			Tare Cont	giner						
			Wt. of Dry S				-			
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Moisture Co							
			Vol. Contai							
S I			Vol. Dry So							
39		2	Shrinkage \ Shrinkage L							
e										
			25	= w (Y	<del>-Vo</del> x 10	00)				
o o w					110					
Σ			Descriptio	n of Sam	ple:					
38										
			Remarks:	CURINA	TIME	866 H	OURS			
37										
	111111111111111111111111111111111111111	30 10								
7 8 9 10 15 Number	of Blows									



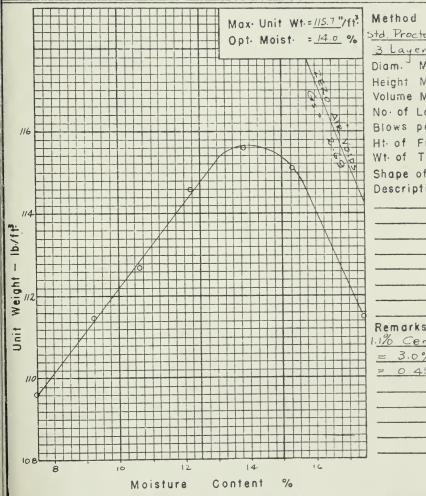
UNIVERSITY of ALBERTA

DEP'TO OF CIVIL ENGINEERING
SOIL MECHANICS LABORATORY

COMPACTION TEST

PROJECT	
SITE	
SAMPLE	CRAWFORD PIT -#4
LOCATIO	
HOLE	DEPTH
TECHNIC	IAN MILLIONS DATE 19/1/59

Tric	ı Number	1	2	3	4	5	6	7
	Mold No.							
	Wt Sample Wet + Mold	3517.4	3577.1	3620.1	3679.5	3724.6	37413	3.716.0
	Wt. Mold	1742-8	1742.8	1742.8	1742.8	1742.8	1742.8	17428
P.é.	Wt. Sample Wet	1774.6	1834.3	1877.3	1936.7	1981.8	1998.5	1973.2
-	Volume Mold	1/30.12	1/20.12	1/30.12	1/30.12	1/30.12	1/30.12	1/30.12
nit	Wet Unit Weight 1b/ft3 Dry Unit Weight 1b/ft3	117.8	121.8	124.7	128.6	131.6	132.7	131.0
20	Dry Unit Weight 1b/ft.3	109.6	111.5	112.7	114.6	115.6	115.1	111.5
in in	Container No	V72	A/3	V 2 5	V42	V26	AIS	V23
	Wt Sample Wet + Tare	164.81	158.67	177.63	143.04	157.99	129 88	163.17
Co	Wt. Sample Dry + Tare	158.22	151.10	168.70	134.80	147.71	121.50	144.75
e.5	Wt· Water	6.59	7.57	8.93	8.24	10.28	8.38	14.02
구보	Tare Container	69.97	69.01	84.86	63.38	73.50	66.61	69.34
0 0	Wt. Dry Soil	88.25	82.09	83.84	67.42	74.21	54,86	80.41
ΣO	Moisture Content	7.47	9.22	10.65	12.22	13.85	15.28	17.44



Method of Compaction
Std. Proctor Hammer & Mold
3 Layers - 13-13-13 Blows
Diam. Mold = 4"
Height Mold = 4.6"
Volume Mold 1/30.12
No. of Layers 3
Blows per Layer 13
Ht. of Free Fall 12"
Wt. of Tamper 5.5 16s.
Shape of Tamping Face
Description of Sample

	Ren	narks.					
l	.1%	Cem	ent	10	27177	J.5 7#	4
	=	3.0%	Cer	nent	17	_ #	40
	=	0.45	%	1)	13		3 "
	-						



	UNIVE							PROJE	CT						
	DEP T.	of C	IVIL	ENG	INEE	RING			EC	RAWF	OKD	- 3"			
	SOIL	MECHA	NICS	LA	BORAT	ORY		LOCAT							
	TRI-A							HOLE DEPTH TECHNICIAN 5 2 DATE 28/1/3							
	IIIIA	NIAL	00	VIAIL I	ILOO	IOIA		TECHN	IICIAN	50	W.	DATE	28/1/	54	
Mach	ine Dat	a:-						Description of Sample: -3" NATIVE							
Mach	ine No.			T.O.				GRAVE	56	NO AC	VITIVE	Co	MPAC	TED	
	plicatio									110157					
Wt. Lo	ading (	Block -	+ Pist	on (am	s.)	1 Kg,	n	LINER	\$	CIRCUM	FERE	NCE G	AUGE	LOFO	
					SPECII				DATA						
Spec	imen N	lumber					1-	2	1	3	4	5		6	
	ral Pr			TH IK	m /50	c.m.	0.30								
Len				ches	11/29	0774.	23 5/8								
Are				q. cms.			720					1			
	me		0	- C - S -	cu f	2+	1.527					1		-	
	Unit We	iaht	11	bs/cu.f	t. x		133.6								
Go=	· Vo	lume	Soil	Solide	V				1.	1== 5	. (1-	_ 2 4	2 11		
						veT	140.2	-	И	IET So	IL USE	9 = 11	4 100		
	Tare + S						12.6	,				-			
			Mule	u i	enu		13877					-			
	Tare + S			T									_		
	ber an	d weld	int of	lare			1297					-			
	Soil	Wainh	4 0 6 11				12580	2	-			-			
Befo		Weigh										_			
Tes	1		ontent								+				
			satura	ition							-				
Aft	C 1	Weight					927						-		
Te	)			ontent			7.4					-			
		Degre	e of	satura	tion	%	70								
Load	Dial	Strain	Area	01	Load	DIGI		Area	5.	Load	Dial	Strain	Area	51	
Pan	Rdg				Pan	Rdg				Pan	Rdg.				
							-			-					
	DIAL		STRAIN	<u>AC</u>	AREA	Tr-Tin	14,			-					
•	ROG.	R061			-		-			1					
Kgm.	175.	195.	%	196.	cm²	Kanlen	Kamlen	È.							
	7 2.2			-	773.11		23			-	-	-			
0	2.919	7	- 0.7	-	720	03		-				-			
200	2.910	40	.14	-	720	.30									
300	2.849	1.6		1/32	722	.44	.79								
400						1	-	1				1			
500	2.804		.49	1/16	723	.58	88	1							
200	2.804	40/16		3/32	723	.72	1.02								
600	2.750	40 1/16 40 3/32 40 1/8	·71 ·96	3/32 1/8	724	.72 .86	1.02						rana danishingan		
700	2.750 2.692 2.633	40 1/16 40 3/32 40 1/8 40 3/16	·71 ·96 /·21	3/32 1/8 3/16	724 725 728	.72 .86 .99	1.16								
600 700 800	2.750 2.692 2.633 2.564	40 1/16 40 3/32 40 1/8 40 3/16 40 1/4	.71 .96 1.21 1.50	3/32 1/8 3/16 1/4	724 725 728 730	.72 .86 .99 1.13	1.16 1.29 1.43								
600 700 800 900	2.750 2.692 2.633 2.564 2.485	40 1/16 40 3/32 40 1/8 40 3/16 40 1/4 40 3/8	.71 .96 1.21 1.50 1.83	3/32 1/8 3/16 1/4 3/8	724 725 728 730 735	.72 .86 .99 1.13 1.25	1.02 1.16 1.29 1.43 1.55								
600 700 800 900 1000	2.750 2.692 2.633 2.564 2.485	40 1/16 40 3/32 40 1/8 40 3/16 40 1/4 40 3/8 40 1/2	.71 .96 1.21 1.50 1.83 2.22	3/32 1/8 3/16 1/4	724 725 728 730	.72 .86 .99 1.13 1.25	1.16 1.29 1.43								
600 700 800 900 1000 1100 1200	2.750 2.692 2.633 2.564 2.485 2.393 2.286 2.122	40 332 40 38 40 3/16 40 3/16 40 3/16 40 3/18 40 1/2 40 5/18 40 15/16	.71 .96 1.21 1.50 1.83 2.22 2.64 3.37	3/32 1/8 3/16 1/4 3/8 1/2 5/8 15/16	724 725 728 730 735 740	.72 .86 .99 1.13 1.25	1.02 1.16 1.29 1.43 1.55								
600 700 800 900 1000 1100 1200 130J	2.750 2.692 2.633 2.564 2.485 2.393 2.286 2.122 1.820	40 1/16 40 3/32 40 1/8 40 3/16 40 1/4 40 3/8 40 1/2 40 5/8 40 15/16 41 1/2	.71 .96 1.21 1.50 1.83 2.22 2.64 3.37 4.65	3/31 1/8 3/16 1/4 3/8 1/2 5/8 15/16 1 1/2	724 725 728 730 735 740 745 757 779	.72 .86 .99 1.13 1.25 1.38 1.50 1.61	1.02 1.16 1.29 1.43 1.55 1.68 1.80 1.91 2.00								
600 700 800 900 1000 1100 1200 130J	2.750 2.692 2.633 2.564 2.485 2.393 2.286 2.122 1.820	40 332 40 38 40 3/16 40 3/16 40 3/16 40 3/18 40 1/2 40 5/18 40 15/16	.71 .96 1.21 1.50 1.83 2.22 2.64 3.37 4.65	3/31 1/8 3/16 1/4 3/8 1/2 5/8 15/16 1 1/2	724 725 748 735 735 740 745 757	72 -86 -99 1-13 1-25 1-38 1-50 1-61	1.02 1.16 1.29 1.43 1.55 1.68 1.80								
600 700 800 900 1000 1100 1200 130J	2.750 2.692 2.633 2.564 2.485 2.393 2.286 2.122 1.820	+0'/16 40'32 40'/8 40'/4 40'/4 40'/8 40'/2 40'/8 40'/8 40'/12 40'/12 40'/12	.71 .96 1.21 1.50 1.83 2.22 2.64 3.37 4.65 5.95	3/31 1/8 3/16 1/4 3/8 1/2 5/8 15/16 1'/2 2'/4	724 725 748 730 735 740 745 757 779 810	.72 .86 .99 .1.13 .1.25 .1.38 .1.50 .1.61 .1.70 .1.75	1.02 1.16 1.29 1.43 1.55 1.68 1.80 1.91 2.00								
600 700 800 900 1000 1100 1200 130J	2.750 2.692 2.633 2.564 2.485 2.393 2.286 2.122 1.820	+0'/16 40'32 40'/8 40'/4 40'/4 40'/8 40'/2 40'/8 40'/8 40'/12 40'/12 40'/12	.71 .96 1.21 1.50 1.83 2.22 2.64 3.37 4.65 5.95	3/31 1/8 3/16 1/4 3/8 1/2 5/8 15/16 1 1/2	724 725 748 730 735 740 745 757 779 810	.72 .86 .99 .1.13 .1.25 .1.38 .1.50 .1.61 .1.70 .1.75	1.02 1.16 1.29 1.43 1.55 1.68 1.80 1.91 2.00								



I INVERSIT OF ALBERTA									PROJECT							
DEPT of CIVIL ENGINEERING									SAMPLE CRAWFORU - 3" & 0.45%							
		MECHA						LOCATION NORMAL PORTLAND								
								HOLE DEPTH								
	IRIA	XIAL		ארואונ	E55	ION		TECHNICIAN 5 d al DATE 22/12/58								
Mach	ine Da	t a :-											ample:			
Mach	ine No	·	10.			-	- 3" /	VAT	VE	GR	AVEL -	+0.45	3/0 N.	7.		
		on Fac											no fo			
					9)	21 K	am.									
Wt. Loading Block + Piston (gms.) 21 Kgm. no circ gauge.																
					SPECI	MEN			[	TAC	A					
Spec	cimen	Vumber					- 1		2			3	4	5		6
Late	eral P	ressur	e (c	572 ) K.	gm/5.	.cm.	0.30	)								
Length inches						23 7/	8									
Area sq. cms.						730										
Volu	ım e		С	. C. S.			1.56	/								
Dry	Unit W	eight	1	bs/cu-f	t. 80	4	122.0	,								
G <sub>S</sub> =	· V	olume				et.	130.0				W	ET So	12 Use	= = =	03/	6s
		Soil +														
		Soil+					554	Z.								
	Tare +						524									
		d weigh	tht of	Tare			77.						,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1		
	Soil	u were	111 01	1416			447							-		
	3011	Walah					77/	5	-					-		
Befo	re	Weigh							-					-		
Test Moisture content																
Degree of saturation														-		
After Weight of water							29		-					-		
Te	st			ontent			6.6	-						-		
		Degre	e of	satura	tion	%	47									
Load	Dial	Strain	A # 0 #		Load	Dial	Ctrai		Area	<u></u>		Load	Dial	Strain	٨٠٥	
on Pan	Rdg	Struin	Areu	01	pan	Rdg	.  31161	"	AISU	0 1		Pan	Rdg-	Sirdin	Aie	
LOAD	DIAL	STRAIN	AREA	VV.	T											
	ROG.				ļ						-					-
11		2/		1. ( )	12	,		+			-					-
Kam.	175.	9/0	54.cm	19-16-	Kym, Cm			-			$\dashv$			-		
0	1.013	-	730	.03	.33			+			_					
100	1.013	-	,,,,,,	.16	.46			+			7					
	1.013	-	11	.30	.60											
300	5	-	17	.44	.74			-								
400	1.012	-	12	.58	.88			4			-			-		ļ
	1.007	02	- 11	.71	1.01						-			-		-
8	0.995	.08	731	.85	1.15								1	-		-
700	0.484	17	731	1.12	1.42			1								-
3	0.962	21	731	1.26	1.56											
-	0.951	.26	732	1.40	1.70											
1100		.31	732	1.53	1.83		-	-								
1200		135	732	1.67	1.97		-	-						1		
1300		1 .42	733	1.80	2.10			-								
1500	0.891	.51	733	2.07	2.37			-		-						
1550	0.815	-82	1	2.14	2.44									-		
1600	0.740	1.14		2.20	2.50			Ţ								-
1633	0.620	1.64		2.23	2.53			-			_					
1000	1	1 1	LURE	1 BY 1	BULG	111/										



PROJECT UNIVERSITY of ALBERTA SITE DEPT of CIVIL ENGINEERING SAMPLE CRAWFORD -3" \$ 0.45% SOIL MECHANICS LABORATORY LOCATION NORMAL FORTLAND TRI-AXIAL COMPRESSION HOLE DEPTH TECHNICIAN O DATE 21 2 58 Machine Data:-Description of Sample: -3" MATINE Machine No .\_\_ STAVEL + 0 45% N.P. COMPACTED Multiplication Factor\_ 27 6.1% MOISTURE CONTENT Wt. Loading Block + Piston (gms.) at Agm SATURATED IN 12 HRS BY VACUUM SPECIMEN DATA Specimen Number -3 4 5 2 6 Lateral Pressure (07%) Kgm/sq.cm 0.30 Length inches 241/4 sq. cms. Area 730 Volume 1.584 C-C. 3. Cu ft Dry Unit Weight | Ibs/cu.ft. &d 124.7 Gs= · Volume Soil Solids Ywet 132.1 WET Sail L'SED = 210 Wt. Tare + Soil + Water at start Wt. Tare + Soil + Water at end 7698.0 Wt. Tare + Soil 7020.0 Number and weight of Tare 771.6 NO FELT NO CIRU. GRUGE. Wt. Soil 6248.4 Weight of water Before Moisture content 6.1 Test Degree of saturation Weight of water 618.0 After Moisture content 10.8 Test Degree of saturation 84 Load Load Load Dial Dial Dial Strain Area 5. Strain Area or Strain Area or on on CA Rdg. Rdg Rda Pan Pan Pan LOAD DIAL STRAIN AREA V, - V. 4 ROG cm2 Kamlon Kamlon 9/0 Kan 1115 0 0.717 730 33 .03 .10 50 716 730 40 .47 .715 .01 ./1 100 730 150 1713 .02 730 .23 53 200 .712 730 .60 .02 .30 .37 250 710 .03 730 .67 .708 .74 .03 730 .44 300 .81 .706 730 151 350 .05 400 .702 .06 730 .58 .88 730 .95 .65 450 697 .08 500 .10 730 1.01 692 .71 ,78 1.08 .684 .14 731 550 .85 731 1.15 600 .676 .17 .22 .92 1.22 650 .665 731 651 .28 732 .99 1.29 700 1.05 1.35 -634 .35 732 750 1.12 1.42 .607 .46 733 800 1.18 1.48 850 .515 .84 734 FAILURE BY BULGING 1.51 2.45 748 1.21 887 .130



UNIVERSITY of ALBERTA
DEP'T of CIVIL ENGINEERING
SOIL MECHANICS LABORATORY
SIEVE ANALYSIS

PROJECT
SITE
SAMPLE CRAWFORD FROM
LOCATION TRIAXIAL TEST
HOLE
TECHNICIAN A L DATE

					-	THE RESERVE AND PERSONS NAMED IN	
Total Dry Weight	Sieve	Size of (		Weight Retained gms.	Total Wi Finer Than gms.	Percent Fuer Thon	% Finer Than
of Sample 20806	No.	Inches	Mm.	gms.	g ms.	THE THON	Basis Orig.
Initial Dry Weight							
Retained No. 4							
Tare No.		3		_	20806		100
Wt. Dry + Tare		1 1/2		1393	19413		93
Tore		3/4	19.10	3776	15637		75
Wt. Dry		3/8	9.52	3334	12303		59
	4	·185	4.76	3429	8874		42.6
Passing	4					·	
Initial Dry Weight							
Passing No. 4	10	.079	2.000	2859	6015		28.8
Tare No	20	.0331	.840				
Wt. Dry + Tare	40	.0165	.420	2438	3577		17.1
Tare	60	.0097	·250				
Wt. Dry	100	.0059	.149				
	200	.0029	.074	1228	2349		11.2.
Passing	200						

Description of Sample \_\_\_\_\_\_ Method of Preparation \_\_\_\_\_

Remarks\_

Time of Sieving. Sand Sizes Gravel Sizes Size Sjeve #60 #100 100 90 D10 =\_\_\_ 30 D60=\_\_\_\_m.m. C11 =-70 £60 E SO 40 20 10 0100 10 Grain Size-Mm. Note: M·I·T· Grain Size Scale









B29781